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JOHNS MANVILLE
IP Department
10100 W Ute Avenue
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Case Docket No. 7237
Date: October 21, 2008

Mail Stop Appeals - Patents
COMMISSIONER OF PATENTS
PO Box 1450
Alexandria, VA 22313-1450

Re: Application of: Jaffee
Serial No.: 10/718,007
Filed: November 20, 2003
For: TOUGH, FLEXIBLE MATS

Art Unit: 1794
Examiner: MATZEK, Matthew D

Transmitted herewith is/are the following document(s) related to the above-identified application:

[ ] Notice of Appeal

[X] Appeal Brief in reply to Notice of Non-Compliant Appeal Brief mailed on September 29, 2008.

[ ] Request for Oral Hearing

Please extend the time for filing the Notice of Appeal _____ ( ) months to _______________.

The fee has been calculated as shown below:

Notice of Appeal	$510.00	
Appeal Brief	$510.00	
Request for Oral Hearing	$1030.00	
Fee for Extension of Time		
1 month $120.00, 2 months $460.00, 3 months $1050.00, 4 months $1640.00, 5 months $2230.00		
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In The United States Patent and Trademark Office

In re Application of: Jaffee

Art Unit: 1794

Serial No. 10/718,007

Case Docket No. 7237

Filed: November 20, 2003

Examiner: Matzek, Matthew D.
October 21, 2008

For: **Tough, Flexible Mats**

Commissioner of the Patents & Trademarks
Alexandria, VA 22313-1450

Dear Sir:

This appeal is from the Final Office Action mailed on February 1, 2008, the Advisory Action mailed April 4, 2008, rejecting claims 51-64. 71-84, 91-94 and 99, set forth in the Claims Appendix of this brief and the Notices of Non-Compliant Appeal Brief mailed on July 3 and September 29, 2008.

SECOND AMENDED APPEAL BRIEF

I. Real Party In Interest:

The real party in interest is Johns Manville, assignee of the inventor, Jaffee.

II. Related Appeals and Interferences

NONE

III. Status of the Claims

Claims 1-50, 65-70, 85-90 and 95-98 having been cancelled earlier, the final rejection of claims 51-64. 71-84, 91-94 and 99 under 35 USC 103(a) is hereby appealed.

PAGE 2/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

IV. Status of Amendments

After the Final Office Action mailed February 1, 2008, a Rule 1.116 Amendment and Request For Reconsideration was filed on March 18, 2008. This Rule 1.116 Amendment was entered and the rejection under 35 USC 112, second paragraph was withdrawn, but the Final Rejection under 35 USC 103 of the appealed claims was maintained.

V. Summary of the Claimed Subject Matter:

The invention of independent claim 51 is fibrous nonwoven mats having compositions comprising

about 88-92 wt. percent chopped glass fibers, see page 2, lines 17-18, page 3, lines 30-32, Example 2, page 9, lines32-33 and Example 3, page 10, lines 19-20, having a diameter in the range of about 13-17.5 microns, see page 5, lines 12-13 and original claim 91, and lengths in the range of about 0.7 - 1.1 inches, see page 5, line 14,

about 8-12 wt. percent man made polymer fibers, see page 4, lines 22-24, Example 3, page 10, lines 20-21and Example 2, page 9, lines33-34, selected from the group consisting of polyester, polypropylene, nylon, PBT, polyacrynitrile, and polybenzimidizole, see page 4, lines 26-27, and

the fibers bound together with about 25 +/- 5 wt. percent, see the top of page of 3, a binder that is at least partially cured, page 3, lines 21-25, and consists essentially of, before drying and curing, a homopolymer or a copolymer of polyacrylic acid and a polyol, see page 2 of the spec., lines 35-36 and with or without a polycarboxy polymer; see page 6, lines 31-33 these mats having unique properties including

PAGE 3/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

a basis wt. of 2.3 to about 2.6 lbs./100 sq. ft., see page 8, lines 9-10, Example 3, page 10, line 27 and Example 2, page 10, line 4,

a thickness in the range of about 38 - 48 mils, see Example 2, page 10, line 6,

a Taber Stiffness of at least 50 gram cm, page 3, line 17,

high flame resistance passing the National Fire Protection Association's NFPA Method #701 Flammability Test, page 3, lines 14-16, and

unexpected properties, <u>after scoring and folding</u>, see page 1, lines 33-35, including excellent tensile strength, flex and recovery properties, see page 3, lines 6-11, that make the mats uniquely suitable, for connecting webs joining and spanning between an exposed facer sheet and a different backer sheet in unique compressible ceiling tiles disclosed in U.S. Published Patent Application No. 20020020142 ,see page 3, lines 1-5 and the Evidence Appendix. Such tile can be collapsed and compressed to a thin, flat condition, folding the strips of claimed mats, to reduce storage and shipping costs, the strips of mats springing back, see page 3, lines 1-5 .

The invention of independent claim 91 is fibrous nonwoven mats having compositions comprising

about 84-92 wt. percent chopped glass fibers, see page 2, lines 30-32, having a diameter in the range of about 13-17.5 microns, see page 5, lines 12-13 and original claim 91, and lengths in the range of about 0.7 - 1.1 inches, see page 5, line 14,

about 8-16 wt. of polyester fibers, see page 2, lines 19-20, having a length of about 0.25 +/- 0.07 inch, see original claim 62 , and

the fibers bound together with about 20-30 wt. percent, see page 5, lines 20-22,

PAGE 4/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

with a cured resin, page 2, line 35, and consisting essentially of, before drying and curing, a homopolymer or a copolymer of polyacrylic acid and a polyol, see page 2 of the spec., lines 35-36 and with or without a polycarboxy polymer, see page 6, lines 31-33 these mats having unique properties including

a basis wt. of 2.3 to about 2.6 lbs./100 sq. ft., see page 8, lines 9-10, Example 3, page 10, line 27 and Example 2, page 10, line 4,

a thickness in the range of about 38 - 48 mils, see Example 2, page 10, line 6,

a Taber Stiffness of at least 50 gram cm, page 3, line 17,

high flame resistance passing the National Fire Protection Association's NFPA Method #701 Flammability Test, page 3, lines 14-16, and

unexpected properties, after being scored, folded and compressed, see page 1, lines 33-35, including the ability to spring back, see page 3, lines 1-5, excellent tensile strength, flex and recovery properties, see page 3, lines 6-11, that make the mats uniquely suitable, for connecting webs joining and spanning between an exposed facer sheet and a different backer sheet in unique compressible ceiling tiles disclosed in U.S. Published Patent Application No. 20020020142 (see page 3, lines 1-5 Evidence Appendix). Such tile can be collapsed and compressed to a thin, flat condition, folding the strips of claimed mats, to reduce storage and shipping costs, the strips of mats springing back, see page 3, lines 1-5.

The invention of independent claim 99 is fibrous nonwoven mats having high flame resistance and unexpected tensile strength, flex and recovery properties after scoring and folding, see page 1, lines 33-35, and suitable for use as the scored and folded fibrous nonwoven mats used for vertical webs spanning between an exposed mat and a backer mat in a compressible ceiling tile as disclosed in published U. S. Published Patent Application No. 20020020142 filed April 23,2001, because of the ability of the fibrous nonwoven mat, after being

PAGE 5/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

scored, folded, and compressed, to spring back to the original shape and orientation, see page 3, lines 1-5, the fibrous nonwoven mat comprised of

a blend of fibers comprised of about 88 to about 92 wt. percent of chopped glass fibers, see page 2, lines 30-32, having an average fiber diameter in the range of about 16 +/- 1 microns, see original claim 60, and a length of about 1 inch, see Example 1 on page 9, and

about 8 to about 12 wt. percent of 1.5 denier polyester fibers having a length of about 0.25 +/-0.07 inch, see page 4, lines 22-24, Example 3, page 10, lines 20-21, original claim 62and Example 2, page 9, lines33-34,

the blend of fibers being bound together with about 25 to about 28 wt. percent, based on the dry weight of the fibrous nonwoven mat, see paragraph spanning page 5, lines 16-24, of a cured resin derived from an aqueous homopolymer or copolymer consisting essentially of polyacrylic acid and a polyol, with or without a polycarboxy polymer the average molecular weight of the polyacrylic acid polymer is about 3,000 or less, see page 2 of the spec., lines 35-36 and page 6, lines 31-33,
wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent, see page 3, lines 7-14,

the mat passing the National Fire Protection Association's (NFPA) Method #701 Flammability Test, see page 3, lines 14-16,

the mat having a Taber Stiffness of at least about 50 gram centimeters, see page 3, lines 16-17,

and the mat having an air permeability in the range of about 500 – 700 CFM/sq. ft., see page 3, lines 18-19.

PAGE 6/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

the nonwoven mat having a basis weight in the range of 2.3 to about 2.6 lbs/100 sq. ft, see page 8, lines 9-10, Example 3, page 10, line 27 and Example 2, page 10, line 4, and

a thickness in the range of about 38 - 48 mils, see Example 2, page 10, line 6,

VI. Grounds of Rejection to be Reviewed on Appeal:

Claims 51-64, 71-84, 91,94 and 99, all of the claims on appeal, stand finally rejected under 35 USC 103(a) as being unpatentable over Jaffee (5,772,846) in view of Arkens et al (5,661,213) and further evidenced by Chenoweth et al (4,888,235) as set forth in the Office Action dated 9/14/2007, namely;

a) that Jaffee discloses a nonwoven glass fiber mat comprising a major portion of glass fibers and a minor portion of polymeric fibers with crosslinkable binder (abstract). The mat may be any basis weight but its preferred basis weight is from about 1.8 to about 2.2 pounds per 100 sq. ft. The Examiner takes the position that 2.3 pounds per 100 sq. ft. is provided for by a teaching of about 2.2 pounds per 100 sq. tt. because it is only 0.1 pounds per 100 sq. ft. less than the claimed value and the claimed value is only measured to the nearest 0.1 pound per 100 sq. ft. The applied invention can also be pleated or therformed to produce a variety of composites and laminates (Abstract) and as such is suitable for use as a scored and folded vertical web as now claimed. Jaffee's nonwoven mat comprises glass fibers with diameters between about 9 and 20 microns and lengths of around one inch (col. 3, lines 34-61). The nonwoven mat further comprises polyester fibers of 1.5 denier with lengths as low as 0.25 inch (col. 3, lines 54-61) and acrylic or modified urea formaldehyde binder (Example 1). The binder may be present in the nonwoven mat at up to 35 wt. percent of said mat.

b) Example 1 of Jaffee '846 provides for a mat thickness of 36 mils. The Examiner interprets a thickness of 36 mils to be about 38 or 39 mils. Therefore Jaffee provides for the thickness limitation of claim 1 (sic) because a difference of

PAGE 7/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

10 percent or less between the claimed and applied values would certainly provide for the claimed thickness limitations as their values are not rigid, but instead are "about" a given value. Applicant's Taber stiffness is also provided for in Jaffee in the same manner (stiffness reported in the Table in col. 6 is 33-45, the present inventor agreeing that the stiffness data reported in Jaffee is Taber stiffness data.

c) Jaffee fails to teach the use of claimed binder composition and the specific amounts of glass and polyester fibers, and while the mat of Jaffee provides the claimed fibers, Jaffee fails to use a binder that is at least partially cured and before drying and curing comprises a homopolymer or a copolymer of polyacrylic acid and a polyol.

d) Arkens et al relates to a formaldehyde-free curable aqueous binder containing a polyacid, a polyol and a phosphorus-containing accelerator. The binder may be used as a binder for heat resistant nonwovens such as nonwovens composed of fiberglass or other heat resistant fibers including arimid fibers, polyimide fibers, rayon fibers and certain polyester fibers. This reference also teaches that the polyacid may be a compound having a molecular weight less than about 1000 bearing at least two carboxylic acid groups and that it may be a polymeric acid, preferably an additioin polymer formed from at least one ethylenically unsaturated monomer (such as methacrylic acid, acrylic acid, etc.) (Refer to col. 3, lines 45 through col. 4, line 5). This reference further teaches that the polyol may be triethanolzmine (col. 6, lines 1-6) and the aqueous binder composition may also contain emulsifiers, pigments, fillers, etc. This reference teaches a nonwoven mat containing 1.25 inch long glass fibers bound with 28 wt. percent of the aqueous binder and having a basis wt. of 1.75 pounds per 100 sq. ft. (Example 3). Since both Jaffee and Arkens et al are directed to glass fiber nonwovens comprising heat resistant fibers, the purpose disclosed by Arkens et al would have been recognized in the pertinent art of Jaffee. The Examiner urges it would have been obvious to one of ordinary skill in this art to have modified the mats of Jaffee by providing them with the binder composition of Arkens et al because of the motivation of producing formaldehyde free, heat-resistant nonwovens.

PAGE 8/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

f) The Examiner acknowledges that the teachings of Jaffee modified by those of Arkens et al do not explicity teach all of the properties of the claimed mats, such as the ratio of wet tensile to dry tensile, passing the NFPA Method #701 Flammability Test, but the Examiner urges that these would be inherent in those mats.

g) The claimed range of concentration of man made polymer fibers like polyester fibers encompasses typical values that are found in the prior art evidenced by Chenoweth et al (See Abstract and Table 1). Since each element is recognized as a result effective variable in this field of endeavor and it has been held that discovering optimum values would have required only routine experimentation. It would have been obvious to one having ordinary skill in the art to have made the combined article of Jaffee/Arkens et al/Chenoweth et al with the claimed basis weights, binder percentage and fiber composition, since it has been held that here the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art, In re Aller, 105 USPQ 233.

h) The limitation of "a binder that is at least partially cured and consists essentially of, before drying and curing, a homopolymer or copolymer of polyacrylic acid and a polyol" is met by the composition of Arkens et al and for the purposes of searching for and applying prior art under 35 USC 102 and 103, absent a clear indication in the specification or claims of what the basis and novel characteristics actually are, "consisting essentially of" is construed as equivalent to "comprising", see PPG, 156 F. 3d, 48 USPQ2d at 1355, MPEP 2111.03.

i) The Examiner states that the Jaffe Declaration(s) are insufficient to overcome the rejection because the Examiner urges that the Declarations fail to demonstrate that the prima facie case of obviousness set forth is invalid because it is the Examiner's opinion that the fact that it took an expert in this art 100 trials of different combinations taking 54 days of work "is not deemed excessive and does not contribute to a prima facie case of non-obviousness." Also, the

PAGE 9/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

Examiner stated that applicant has not provided evidence that the instant application is in possession of unexpected results.

VII. ARGUMENTS:

The claimed invention is based on the discovery of a combination of mat properties, compositions and mat parameters for a mat that provides superior performance, after being scored and folded, in a unique compressible ceiling tile described in Published Pat. Application No. 2002/0020142 and also illustrated in Exhibit 1, and the mat having properties, after scoring and folding, unexpected by the inventor in view of the composition and parameters. The issue is whether the combined teachings of Jaffee '876, Arkens et al and Chenoweth make the claimed mats, and their properties after scoring and folding, obvious to one of ordinary skill in the art. They certainly weren't obvious to the present joint inventor Jaffee, the same Jaffee of Jaffee '876, because as shown in paragraphs 1, 2 and 4a of the 37 CFR 1.132 Declaration filed August 23, 2006, Jaffee, who can be considered an expert in glass fiber nonwoven mat field, ran more than 100 trials of different compositions and mat parameters taking more than 54 days to discover the claimed mats (please see Evidence Appendix). While the Jaffee Declarations may not be conclusive evidence of non- obviousness, they certainly are strong evidence of non-obviousness. Applicants believe that the Examiner has erred by either misreading or misunderstanding the references, or has fallen into hindsight reconstruction using applicants own disclosure as a roadmap in making the rejection under 35 USC 103a, for the following reasons:

Re Jaffee '876 teachings:

The Examiner urges that Jaffee teaches a nonwoven mat comprising a major portion of glass fibers and a minor portion of polymer fibers bound together with up to 35 wt. percent of a crosslinkable binder, the mats having a basis wt. in the range of 1.8 to about 2.2 lbs/100 sq. ft. The Examiner urges that Jaffee teaches the claimed mats except for the type of binder, but this is not correct for

PAGE 10/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

the following reasons:

a) The Examiner urges that Example 1 of Jaffee teaches a mat having a thickness of 36 mils, but this mat contains only glass fibers (no man made polymer fibers) bound together with a urea formaldehyde plasticized with a mixture of polyvinyl acetate homopolymer and an acrylic tripolymer, a conventional mat binder. The Examiner further urges that the mat thickness of 36 mils meets the minimum thickness of 38 mils of the claimed mats on the basis that the claimed thickness is within 10% of the claimed thickness, but nothing in Jaffee teaches or reasonably suggests modifying the mat of Example 1 to increase the thickness to 38 mils. Note that none of the mats in the other Examples has a thickness as great as even 36 mils - note in Example 2 where 15 wt. percent of the glass fibers were replaced with 1.5 denier polyester fibers and the plasticized UF binder was replaced with a same amount of a binder of acrylic latex containing a stearylated melamine, the thickness decreased to 31 mils. Also note that the Taber Stiffness of Example 1 was only 37 (please see the Table in col. 6). Thus, the mat of Jaffee '876, Example 1, cannot lead one or ordinary skill in the art to the claimed mats because it doesn't contain any man made polymer fibers and has a Taber Stiffness of only 37. In paragraph No. 3 of the Jaffee Declaration filed November 19, 2007, Jaffee states that the Stiffness data in the Table in col. 6 of Jaffee '876 is in fact Taber Stiffness data. Note that the mat of Example 1 of Jaffee '876 is not a mat of the invention of that reference, but instead is a prior art mat used as a comparative example, see col. 5, lines 33-49.

b) The Examiner urges that Example 2 of Jaffee '876 teaches using 15 wt. percent of 1.5 denier polyester fibers in place of glass fibers to make a mat containing an acrylic latex binder containing a small amount of stearylated melamine, the binder amount the same 19-20 wt. percent as in Exhibit 1 (see col. 5, lines 55-56. This mat had a basis weight of 2.1 lbs./100 sq. ft., but a thickness of only 31 mils and aTaber Stiffness of only 45 (please see the Table in col. 6). The Examiner urges that this Taber Stiffness meets the minimum Taber Stiffness of at least about 50 of the claimed mats because one of ordinary skill in the art

PAGE 11/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

would consider 45 to be at least about 50 - applicants disagree and find no basis for the Examiner's position that the term "about" means within 10 percent of the number. The Examiner did not provide any basis for this allegation and applicants believe that one of ordinary skill in the art would believe that the term "about" means +/- 10 %. nothing in applicants specification suggests to one of ordinary skill in the art that the term "at least about 50" would reasonably mean at least 45. Also, Example 2 is not part of the Jaffee '876 invention, but is instead a part of the prior art as background to the Jaffee '876 invention described in col. 3, lines 16-36 and lines 50-65 and exampled in Examples 3 and 4, please see col. 5, lines 60-67. Also, the mat of Jaffee '876 does not meet the requirements of the claimed mats as pointed out in paragraph No. 4, that the mat disclosed in Example 2 is a commercial mat offered by the assignee of the present application and does not meet the requirements for the collapsible web in the compressible ceiling tile because of insufficient Taber Stiffness and because it doesn't pass the National Fire Protection Associations (NFPA) Method #701 Flammability Test.

c) The invention of Jaffee '876 is actually illustrated in Examples 3 and 4 where Jaffee teaches replacing the acrylic latex binder containing stearylated melamine of Example 2 with a crosslinkable vinyl chloride acrylate copolymer, with or without small amounts of stearylated melamine, with the basis weight of the Example 3 mat being the same, 2.1 lbs./100 sq. ft. as Examples 1 and 2. But this teaching leads one of ordinary skill in the art away from the claimed invenition because the Taber Stiffness of this mat is only 33, even lower than that of the Examples 1 and 2 mats. Also, the Examiner urges that Jaffee '846 teaches mats having a basis weight of 1.8 to about 2.2 lbs. per 100 sq. ft. and that one of ordinary skill in the art would find consider this to extend to 2.3 lbs. per 100 sq. ft. Applicant disagrees because Jaffee '846 clearly teaches that his most preferable basis weight is about 2.1 lbs. per 100 sq. ft. and this leads one of ordinary skill in the art away from the claimed invention of 2.3 to about 2.6 lbs. per 100 sq. ft.

d) Jaffee teaches that the mats of Example 4, dried at a lower temperature of 250 deg. F. can be heated and pleated or therformed to produce performs that can be used to make a variety of composites and laminates (Abstract), or that the mats

PAGE 12/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

can be heated and pleated to form pleated filter elements. The Examiner urges that this teaching of therforming or pleating teaches one of ordinary skill in the art that such (mats) would be suitable for use as a scored and folded vertical web as now claimed. <u>Jaffee does not teach anything about scoring and folding</u>! Scoring a mat, or any material, scratches and damages some of the fibers in or near the surface, making the mat easier to fold and causes it to fold along the scored line when folding forces are applied later. The damage caused by scoring weakens the mat and in prior art mats destroys or greatly reduces their ability to spring back after scoring and folding, especially if they have to resist the weight of another mat to which the ends are attached. One of ordinary skill in the art knows that therforming and pleating is <u>totally different than scoring and folding</u> in that <u>in therforming and pleating the mat surface is not damaged</u>.

e) While Jaffee '846 teaches using a minor portion of polymer fibers like polyester fibers in the mat, Jaffee '846 also teaches that doing so <u>reduces the thickness of the mat to 31 mils</u>. Jaffee '846 does not teach or reasonably suggest that a range of 8-12 percent or 8-16 percent of polymer fibers, like polyester fibers, would produce the claimed properties. Note that the mat of Example 3, Jaffee's invention, <u>had a Taber Stiffness of only 33</u> (Table).

f) The Examiner acknowledges that Jaffee '846 does not teach or reasonably suggest using a binder of a cured resin derived from an aqueous homopolymer or copolymer consisting essentially of polyacrylic acid and a polyol, with or without a polycarboxy polymer, the average molecular weight of the polyacrylic acid polymer being about 3,000 or less, but urges that Arkens et al teaches such a binder for glass fibers and further urges that it would have been obvious to one of ordinary skill in the art to have substituted the binder taught by Arkens et al for the crosslinkable vinyl chloride acrylate copolymer, with or without small amounts of stearylated used by Jaffee '876. Certainly nothing in Jaffee '876 teaches or reasonably suggests doing this.

Re Arkens et al:

PAGE 13/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

g) The Examiner urges that it would have been obvious to have modified Jaffee '876 by using the binder taught by Arkens et al because Arkens et al teaches that their binder is useful for nonwoven fabrics and is formaldehyde free. But, replacing the binder in Jaffee '876 with the binder of Arkens et al does not produce the claimed invention. Also, nothing in Arkens et al teaches or reasonably suggests the parameters of the claimed mat that differ from the teachings of Jaffee '876 or Arkens et al, such as the higher basis weight, the greater thickness, the higher Taber Stiffness, etc. that permit the claimed mats to perform in a superior manner, after scoring and folding, as collapsible webs in compressible ceiling tile. Also, please note that although Arkens et al teach many applications for their mats at col. 8, lines 61-67, use as a facer mat for gypsum wall board or for use as collapsible webs in compressible ceiling tile are not taught or reasonably suggested.

h) Arkens et al teach at col. 8, lines 61-67, various uses for nonwovens containing their binder, but these uses do not mention scoring and folding and do not include use in any ceiling tile much less compressible ceiling tile. Nothing in Arkens et al teaches or reasonably suggests nonwoven mat parameters critical to superior performance of the mat as scored and folded, collapsible webs in compressible ceiling tile. Arkens et al do teach using their binder with glass fibers in Example 3 beginning in col. 9. That mat had a basis wt. of only 1.75 lbs. per 100 sq. ft. Arkens et al's teachings explore the effects of various binder compositions and heat treatments of bindered nonwovens on the wet tensile vs dry tensile strengths of the mats, but does not disclose effects on the mat parameters and properties critical to good performance as scored and folded webs in compressible ceiling tile. There are many formaldehyde free binders for nonwoven mats and there is nothing in Arkens et al that would lead one of ordinary skill in the art to use their binder along with other changes in mat parameters not taught or reasonably suggested in the Arkens et al patent.

Re Chenoweth et al:

PAGE 14/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

i) Chenoweth teaches a compressible blanket or mat that can be used to form automobile headliners and other sound and heat insulating complexly shaped panels. Chenoweth is apparently relied on by the Examiner for teaching a range of polymer fibers in combination with glass fibers, but the glass fibers taught by Chenoweth are not chopped, glass fibers as in the claimed invention, but instead are rotary spun and attenuated glass wool type fibers. Chenoweth teaches compressible blankets, col. 2, lines 45-50 and col. 3, lines 61-64, of finer glass fibers (3-10 microns in diameter) and completely different types of products that the presently claimed nonwovewn mats. Please also see the Jaffee Declaration filed August 23, 2006, paragraph #4d (i –iii) showing that nonwoven mat using 9-10 micron chopped glass fibers had a Taber Stiffness of only 14. Chenoweth also teaches away from the claimed mats, teaching that an optimum proportion of glass fibers is 62 percent and an optimum proportion of polymer fibers is 21 percent and the optimum percent of binder is 16.5 percent. The Examiner urges that applicants' ranges for the concentration of polyester fibers are broad and encompass typical values found in the prior art as evidenced by Chenoweth. With due respect, this allegation is wrong! The claimed mat contains about 8-12 wt. percent (8-16 wt. percent in claim 91) of man-made polymer fibers and this range is not broad. Chenoweth urges in Table 1 that a range of 30-50 wt. percent of synthetic fibers are functional, that a range of 10-30 wt. percent are preferred, and that 21 wt. percent is optimal, and this is in combination, not with 13-17.5 micron chopped fibers about 0.7 to about 1.1 inch long like in the claimed mats, but instead with rotary spun glass fibers having diameters of 3-10 microns (col. 2, lines 21-22) and lengths of less than 1/2 inch to approx. 3 inches (col. 3, lines 67-68. Finally, if just any combination of glass fibers and polymer fibers bonded with any type of binder would have produced the properties and characteristics necessary to perform well in the scored and folded webs of the compressible ceiling tile, set forth in the appealed claims, the present inventor, Jaffee, would not have tried more than 100 combinations before discovering the presently claimed invention, see Jaffee Declaration filed on August 23, 2006, paragraph 1, 2 and 4a, 4b, 4d 1 ii and iii and all of paragraph 4e. Thus, nothing in Chenoweth et al would have led one of ordinary skill in the art to modify the teachings of

PAGE 15/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

Jaffee '846 by using the binder of Arkens et al and to make mats having parameters of the claimed mats.

For the above reasons, applicants believe that the Examiner has failed to establish a prima facie case of obviousness as required under 35 USC 103, and even if so, the evidence in the Jaffee Declaration filed August 23, 2006, particularly paragraphs 1-4 and the Jaffee Declaration filed November 19, 2008, particularly paragraphs 1, 2 and 4a, b, d 1 ii, d 1 iii and all of 4e and respectfully requests the Board of Appeals to reverse the outstanding rejection under 35 USC 103a.

Further, because of the many differences in the parameters of the prior art mats, suggested applications and properties of the prior art mats taught by Jaffee '846, Arkens et al and the compressible blankets of Chenoweth et al from the claimed mats, and the reasons given above regarding the lack of motivation for each difference, the present rejection seems to be an improper hindsight reconstruction using applicants' own disclosure as a template to assemble irrelevant and/or unrelated pieces of prior art to try to establish a case for obviousness, which is improper, see American Medical Systems, Inc. v Medical Engineering Corp., 26 USPQ 2d, 1081, 1091, (District Court of E.D. Wisconsin, 1992) for the principal that one may not use the applicants' disclosure as a "road map" for finding and combining prior art using only hindsight after having the benefit of applicants disclosure. Several discrepancies or deficiencies in the prior art teachings relative to that of the claimed mats, such as the obviously lower stiffness, basis weight and thickness, the different applications suggested by all three references, and the absence of any teaching or reasonable suggestion in any of the references of a fibrous nonwoven mat for use as a collapsible web divider in a compressible ceiling tile of the type described above or that the mat should have a Taber stiffness, basis weight thickness and proper ties of the claimed mats, combined with the teaching away by preferred or optimal combinations taught in Jaffee '846, Arkens et al and Chenoweth et al, including the difference in the type of glass fibers taught by Chenoweth et al are all evidence that the present rejections are improper hindsight rejections.

PAGE 16/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

For these reasons, and the reasons given above, applicant believe that claims 3 and 6 are patentable under 35 USC 103, over any reasonable combination of teachings of Jaffee '846, Arkens et al and Chenoweth et al, and respectfully requests the Board of Appeals to reverse this rejection.

Respectfully submitted,

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PAGE 17/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

VIII. Appendix - Claims

1-50. (Cancelled)

51. A fibrous nonwoven mat having a basis weight of 2.3 to about 2.6 lbs/100 sq. ft., a thickness in the range of about 38 to about 48 mils, high flame resistance and unexpected excellent tensile strength, flex and recovery properties after scoring and folding and being suitable for use as a scored and folded fibrous nonwoven mat for vertical webs spanning between an exposed mat and a backer mat in a compressible ceiling tile because of the fibrous nonwoven mat having the ability, after being scored, folded, and compressed, to spring back to the original shape and orientation, the fibrous nonwoven mat comprising a blend of fibers comprising about 88 to about 92 weight percent chopped glass fibers having a diameter in the range of about 13 to about 17.5 microns and a length in the range of about 0.7 to about 1.1 inches and about 8 to about 12 percent man-made polymer fibers selected from the group consisting of polyester, polypropylene, nylon, PBT, polyacrynitrile, and polybenzimidizole in the fibrous nonwoven mat, the blend of fibers in the being bound together by a binder that is at least partially cured and consists essentially of, before drying and curing, a homopolymer or a copolymer of polyacrylic acid and a polyol, with or without a polycarboxy polymer, the binder being present in the mat in an amount of about 25 +/- 5 wt. percent of the fibrous nonwoven mat, the fibrous nonwoven mat having a Taber Stiffness of at least about 50 gram centimeters and passing the National Fire Protection Association's (NFPA) Method #701 Flammability Test.

52. The mat according to claim 51, wherein the average molecular weight of the polyacrylic acid polymer is about 3,000 or less.

53.The mat according to claim 51, wherein the polyol is triethanolamine.

54. The mat according to claim 52, wherein the polyol is triethanolamine.

PAGE 18/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

55. The mat of claim 51 wherein the man-made polymer fibers are polyester fibers.

56. The mat of claim 52 wherein the man-made polymer fibers are polyester fibers.

57. The mat of claim 53 wherein the man-made polymer fibers are polyester fibers.

58. The mat of claim 54 wherein the man-made polymer fibers are polyester fibers.

59. The mat of claim 51 wherein the binder content is in the range of about 25 to about 28 wt. percent.

60. The mat of claim 59 wherein the polymer fibers are polyester fibers and the glass fibers have an average fiber diameter in the range 16 +/- 1 micron.

61. The mat of claim 51 wherein the polymer fibers are polyester fibers about 1.5 denier and are about 0.25 +/- .07 inch long.

62. The mat of claim 52 wherein the polymer fibers are polyester fibers about 1.5 denier and are about 0.25 +/- .07 inch long.

63. The mat of claim 54 wherein the wherein the polymer fibers are polyester fibers about 1.5 denier and are about 0.25 +/- .07 inch long.

64. The mat of claim 63 wherein the glass fibers have an average fiber diameter in the range 16 +/- 1 micron and the binder content is in the range of about 25 to about 28 wt. percent.

65-70. (Cancelled)

PAGE 19/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

71. The mat of claim 51 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

72. The mat of claim 52 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

73. The mat of claim 53 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

74. The mat of claim 54 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

75. The mat of claim 55 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

76. The mat of claim 56 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

77. The mat of claim 57 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

78. The mat of claim 58 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

PAGE 20/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

79. The mat of claim 59 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

80. The mat of claim 60 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

81. The mat of claim 61 wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

82. The mat of claim 99 wherein the fiber content of the mat is about 90 wt. percent of glass fibers and about 10 wt. percent of polyester fibers, the binder content of the mat is about 25 wt. percent, the basis wt. of the mat is about 2.4 lbs./100 sq. ft. and the thickness of the mat is about 42 +/- 3.

83. The mat of claim 99 wherein the fiber content of the mat is about 88 wt. percent of glass fibers and about 12 wt. percent of polyester fibers, the binder content of the mat is about 25 wt. percent, the basis wt. of the mat is about 2.6 lbs./100 sq. ft. and the thickness of the mat is about 42 +/- 5 mils.

84. The mat of claim 99 wherein the fiber content of the mat is about 92 wt. percent of glass fibers and about 8 wt. percent of polyester fibers, the binder content of the mat is about 28 wt. percent, the basis wt. of the mat is about 2.3 lbs./100 sq. ft. and the thickness of the mat is about 40 +/- 5 mils.

85-90. (Cancelled)

91. A fibrous nonwoven mat having a basis weight in the range of 2.3 to about 2.6 lbs./100 sq. ft., a thickness in the range of about 38 to about 48 mils, a high flame resistance and unexpected tensile strength, flex and recovery properties after scoring and folding and suitable for use as a scored and folded fibrous nonwoven

PAGE 21/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

mat as vertical webs spanning between an exposed mat and a backer mat in a compressible ceiling tile as disclosed in published U. S. Published Patent Application No. 20020020142 filed April 23,2001, because of the ability of the fibrous nonwoven mat, after being scored, folded, and compressed, to spring back to the original shape and orientation, the fibrous nonwoven mat comprised of a blend of fibers comprised of about 84 to about 92 wt. percent of chopped glass fibers having an average fiber diameter in the range of about 13 to about 17.5 microns and lengths within the range of about 0.7 and about 1.1 inches and about 8 to about 16 wt. percent of polyester fibers having a length of about 0.25 +/- 0.07 inch, the blend of fibers being bound together with about 20 to about 30 wt. percent, based on the dry weight of the fibrous nonwoven mat, of a cured resin consisting essentially of a resin derived from an aqueous homopolymer or copolymer of polyacrylic acid and a polyol, with or without a polycarboxy polymer, the fibrous nonwoven mat having a Taber Stiffness of at least about 50 gram centimeters and passing the National Fire Protection Association's (NFPA) Method #701 Flammability Test.

92. The mat of claim 91 wherein the average molecular weight of the polyacrylic acid polymer is about 3000 or less wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent.

93. The mat of claim 91 wherein the polyol is triethanolamine, the glass fibers have a diameter of about 16 +/- 1.5 microns and the mat has an air permeability in the range of about 500 – 700 CFM/sq. ft.

94. The mat of claim 92 wherein the polyol is triethanolamine, the glass fibers have a diameter of about 16 +/- 1.5 microns and the mat has an air permeability in the range of about 500 – 700 CFM/sq. ft.

95 - 98. (Cancelled)

PAGE 22/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

99. A fibrous nonwoven mat having high flame resistance and unexpected tensile strength, flex and recovery properties after scoring and folding and suitable for use as the scored and folded fibrous nonwoven mat used for vertical webs spanning between an exposed mat and a backer mat in a compressible ceiling tile as disclosed in published U. S. Published Patent Application No. 20020020142 filed April 23,2001, because of the ability of the fibrous nonwoven mat, after being scored, folded, and compressed, to spring back to the original shape and orientation, the fibrous nonwoven mat comprised of a blend of fibers comprised of about 88 to about 92 wt. percent of chopped glass fibers having an average fiber diameter in the range of about 16 +/- 1 microns and a length of about 1 inch and about 8 to about 12 wt. percent of 1.5 denier polyester fibers having a length of about 0.25 +/-0.07 inch, the blend of fibers being bound together with about 25 to about 28 wt. percent, based on the dry weight of the fibrous nonwoven mat, of a cured resin derived from an aqueous homopolymer or copolymer consisting essentially of polyacrylic acid and a polyol, with or without a polycarboxy polymer the average molecular weight of the polyacrylic acid polymer is about 3,000 or less, wherein the binder is cured sufficiently that the wet tensile strength divided by the dry tensile strength times 100 equals at least about 35 percent, the mat passing the National Fire Protection Association's (NFPA) Method #701 Flammability Test, the mat having a Taber Stiffness of at least about 50 gram centimeters and the mat having an air permeability in the range of about 500 – 700 CFM/sq. ft., the nonwoven mat having a basis weight in the range of 2.3 to about 2.6 lbs/100 sq. ft and a thickness in the range of about 35 to about 48 mils.

PAGE 23/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

IX. EVIDENCE APPENDIX

The below, copy of each attached, are additional, in addition to teachings in the cited patents, relied upon by applicant.

1. U.S. Published Patent Application No. 20020020142

2. Jaffee Declaration Under 37 CFR 1.132, filed August 23, 2006.

3. Jaffee Declaration Under 37 UFR 1.132, filed November 19, 2007.

4. Exhibit 1, filed June 20, 2007.

PAGE 24/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

US 20020020142A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2002/0020142 A1
Swiszcz et al. (43) Pub. Date: Feb. 21, 2002

(54) COMPRESSIBLE STRUCTURAL PANEL

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(21) Appl. No.: 09/839,373

(22) Filed: Apr. 23, 2001

Related U.S. Application Data

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Publication Classification

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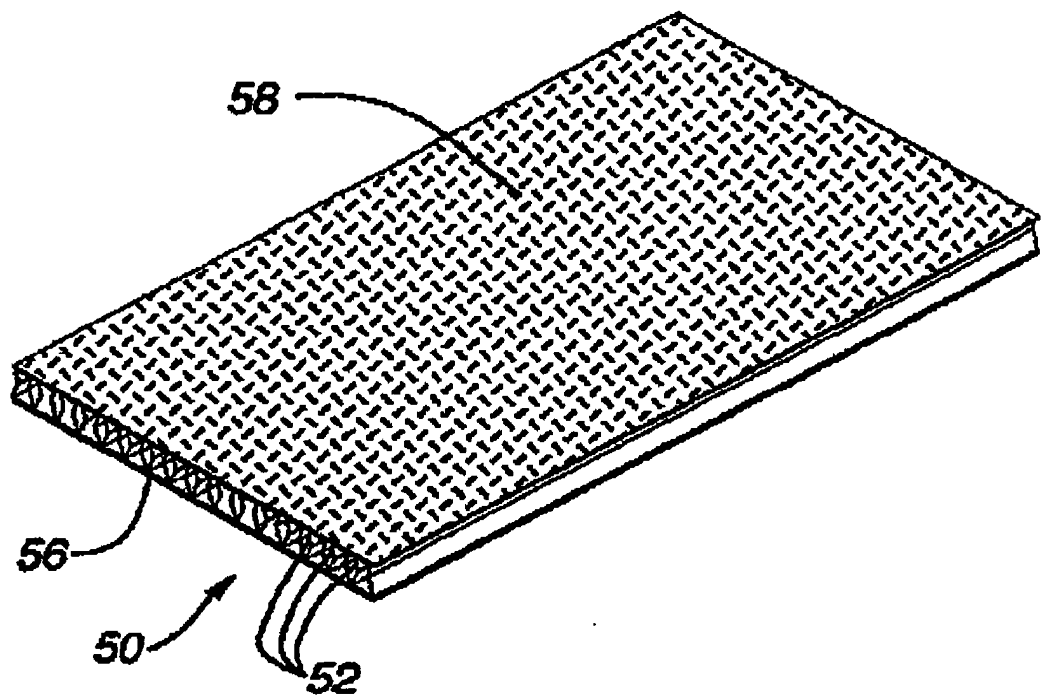
(52) U.S. Cl. 52/783.1; 52/783.11; 52/782.1; 52/309.1

(57) ABSTRACT

A structural panel for use in building structures or in the formation, finish or decoration thereof includes an outer sheet and a connector sheet with a plurality of collapsible or compressible dividers therebetween. The panel in a rest condition is expanded and of a desired thickness for final use but can be compressed into a relatively thin thickness or profile for shipping purposes. The panel is very lightweight but structurally strong and can be selectively bent in one transverse direction if desired. The panel can be easily cut or formed into any predetermined size or shape.



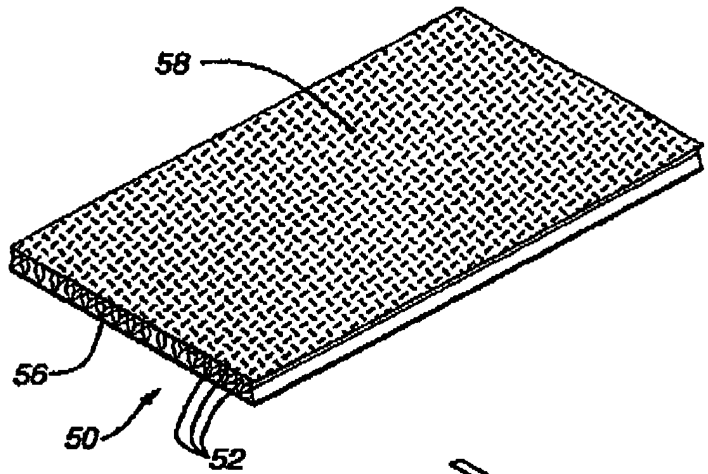


Fig. 1

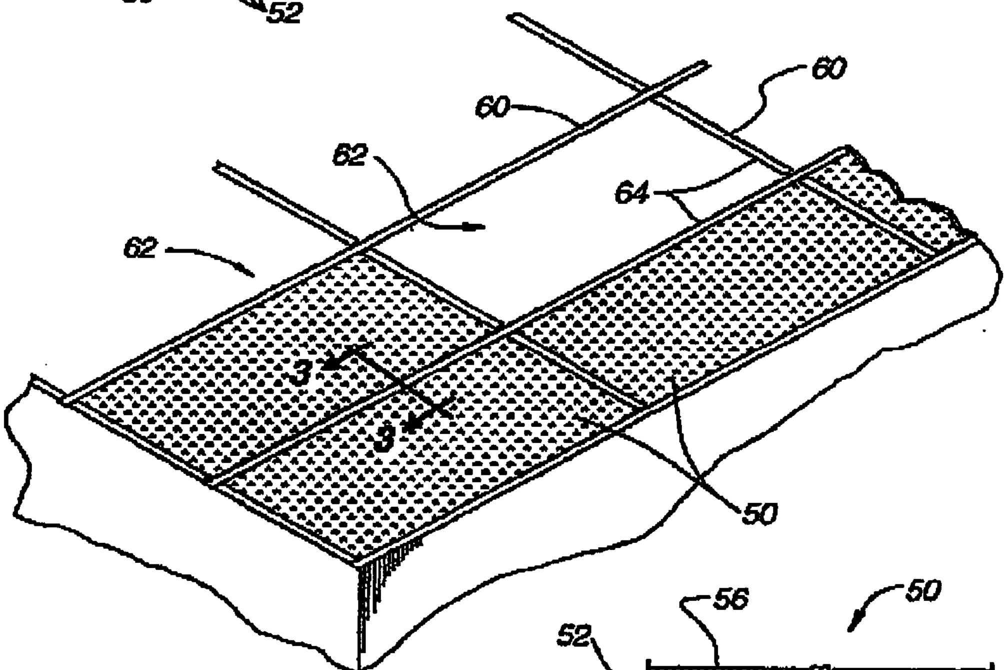
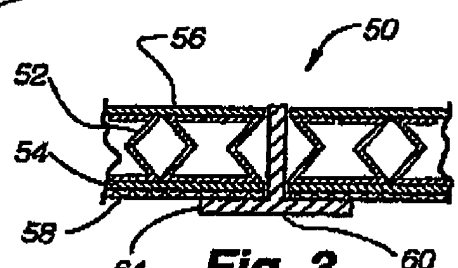


Fig. 2



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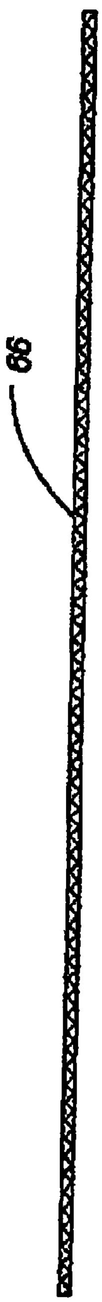

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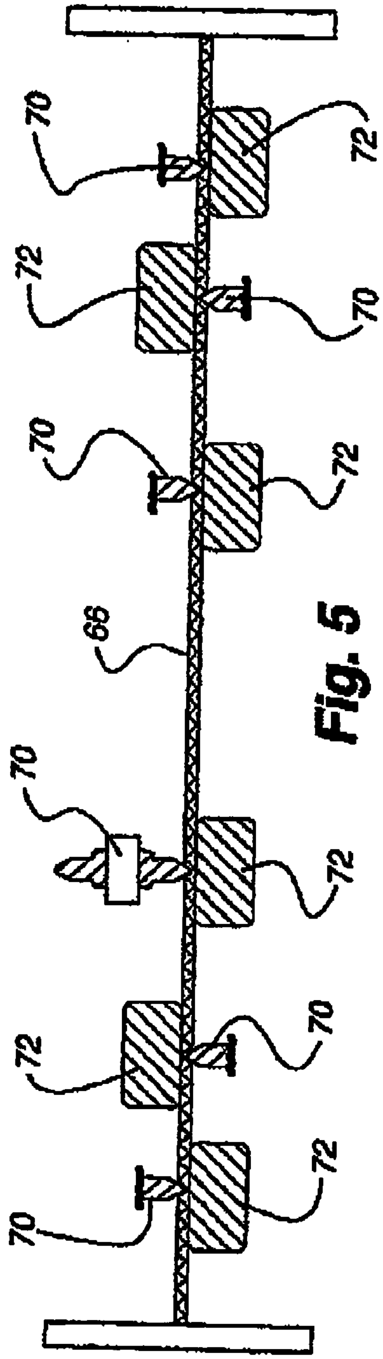

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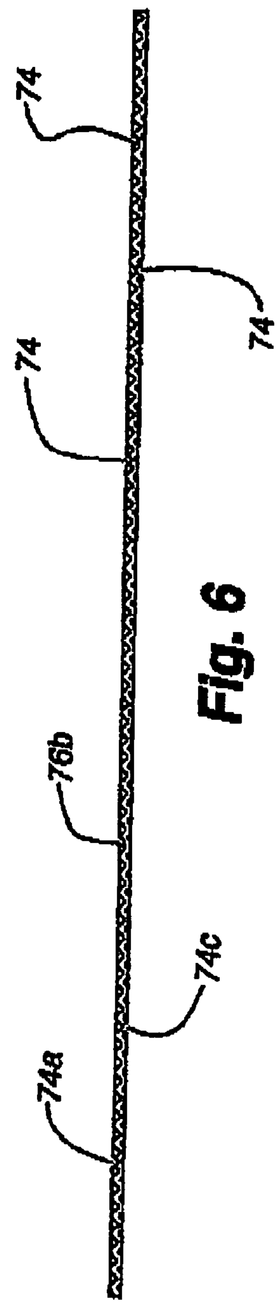
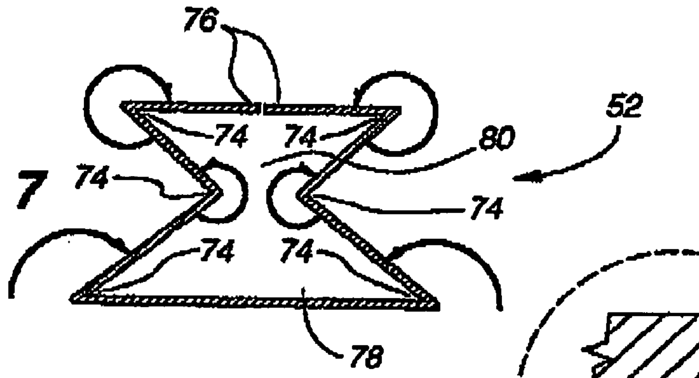


Fig. 6

Fig. 7



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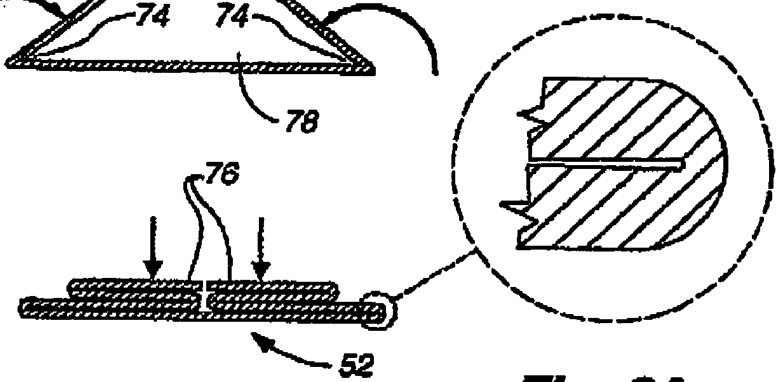


Fig. 8A

Fig. 9

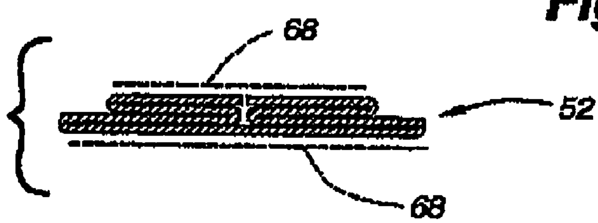
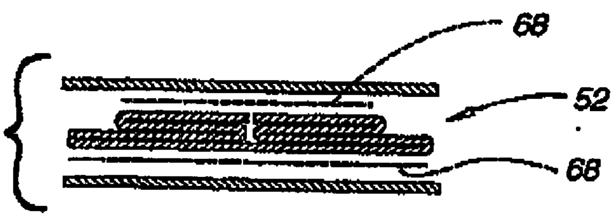


Fig. 10



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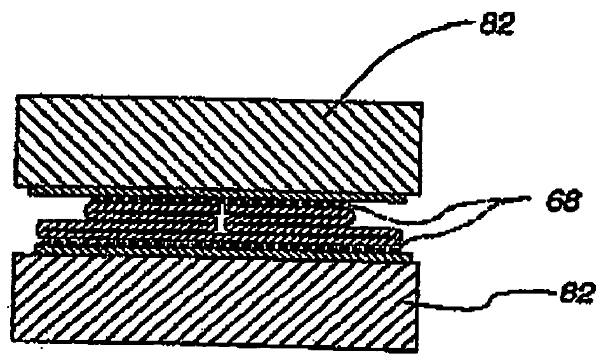

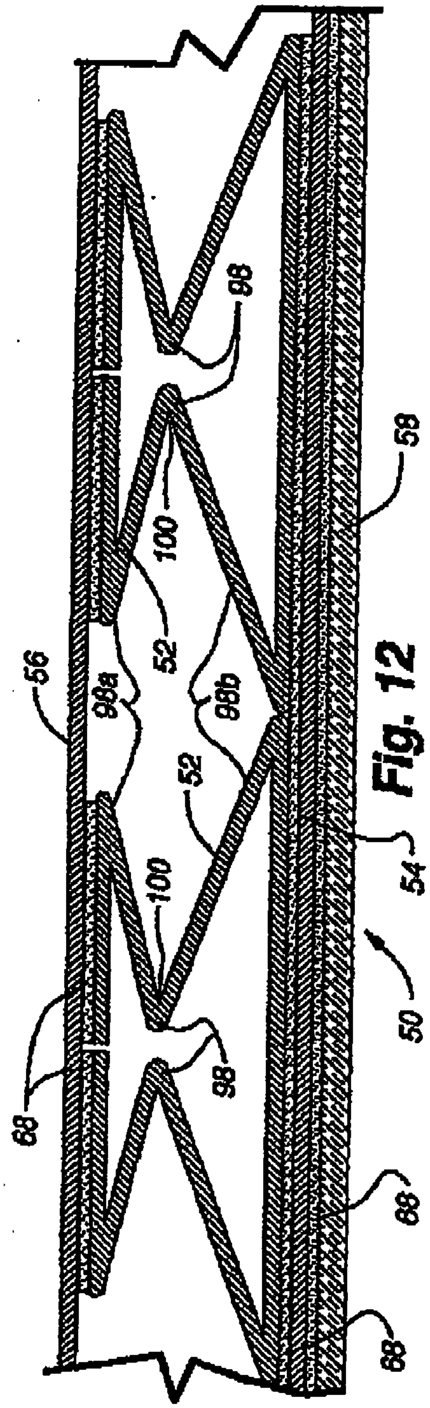

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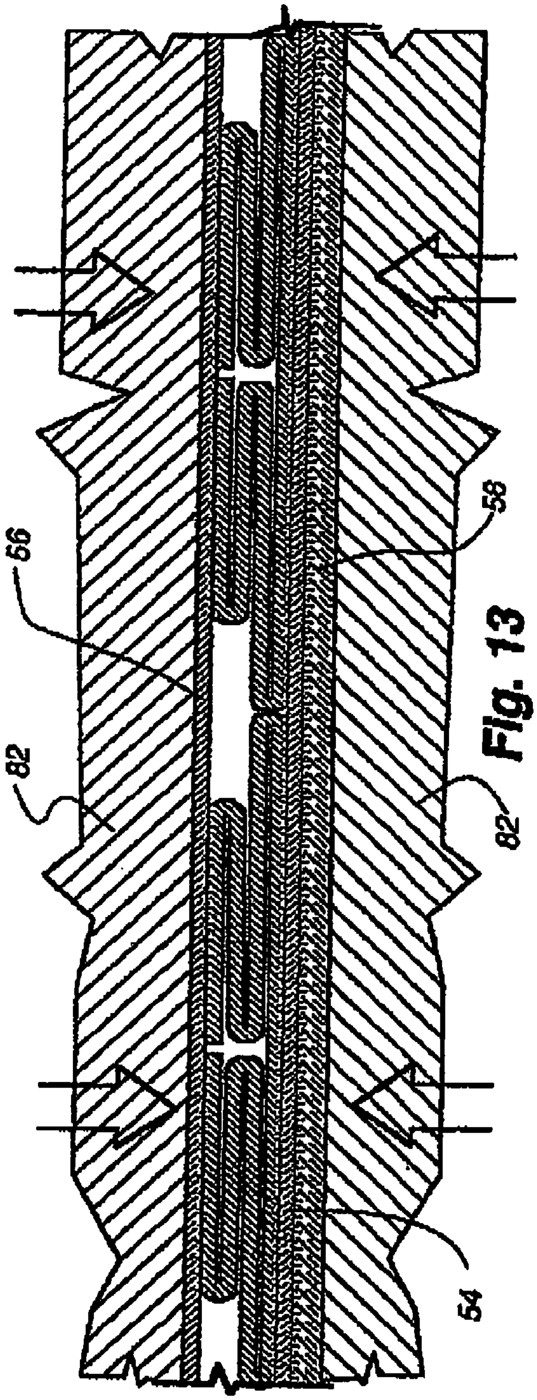

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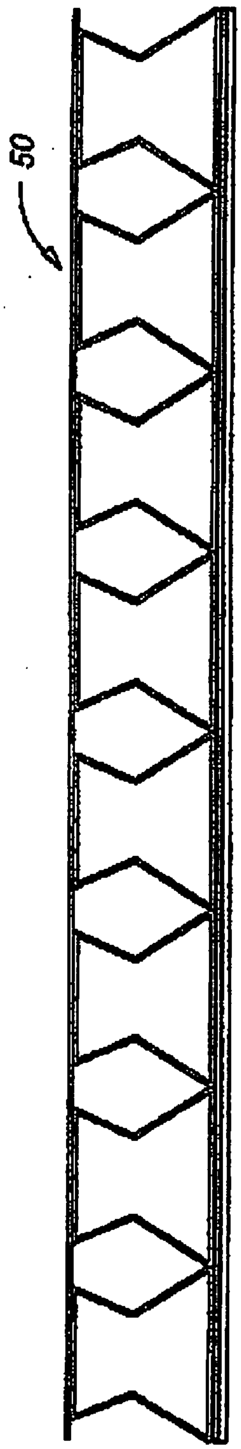
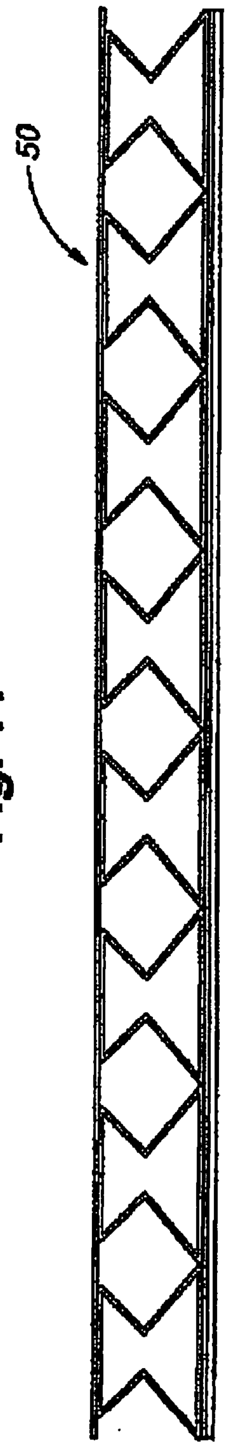


Fig. 14



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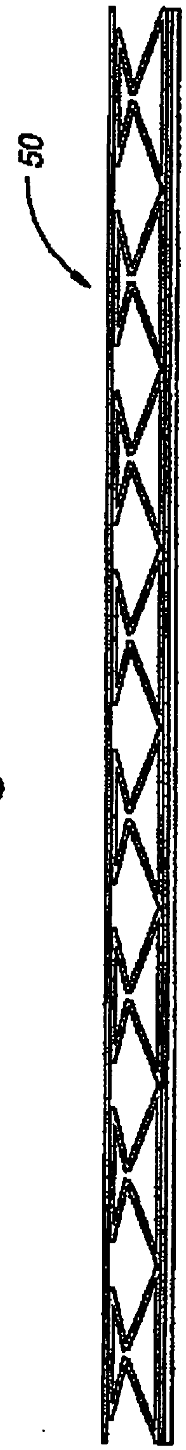
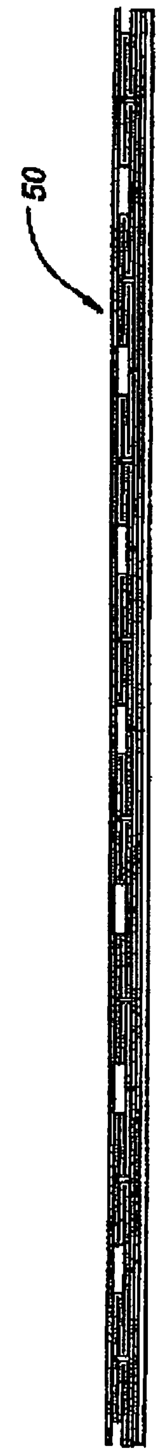


Fig. 16



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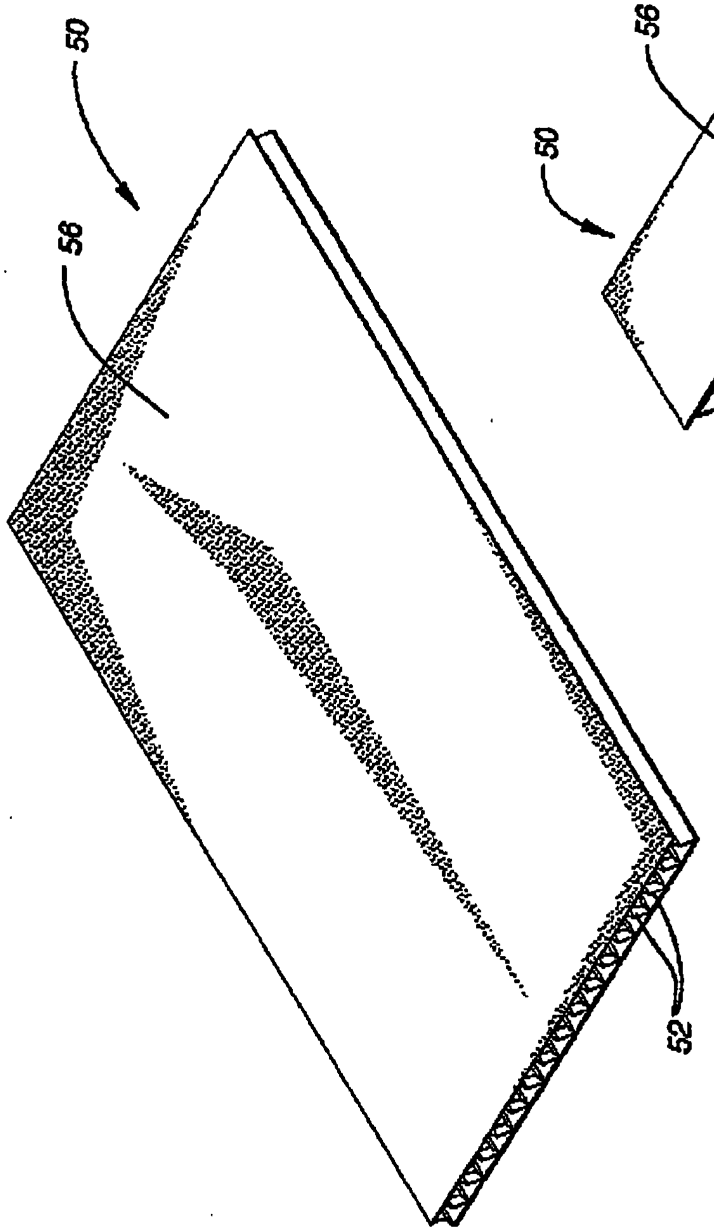


Fig. 18

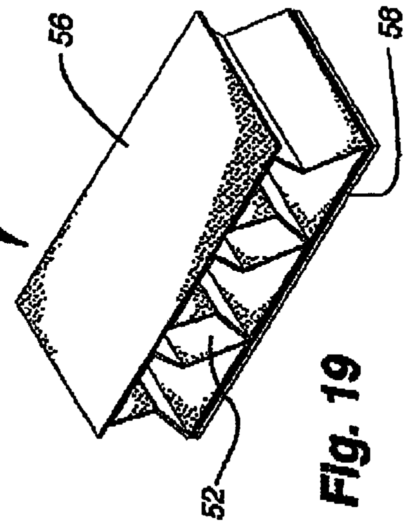
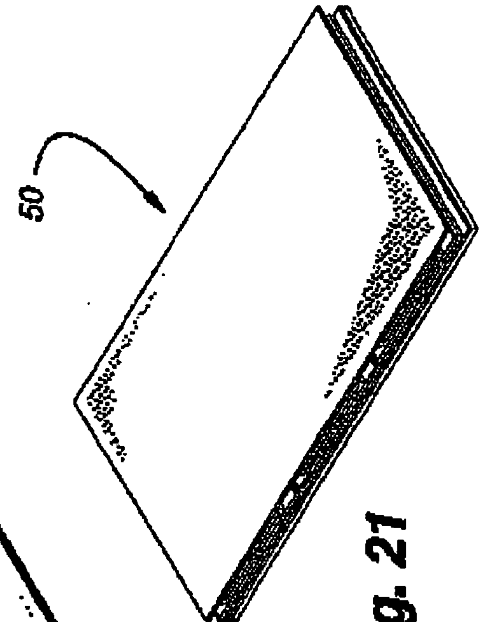


Fig. 19

PAGE 31/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



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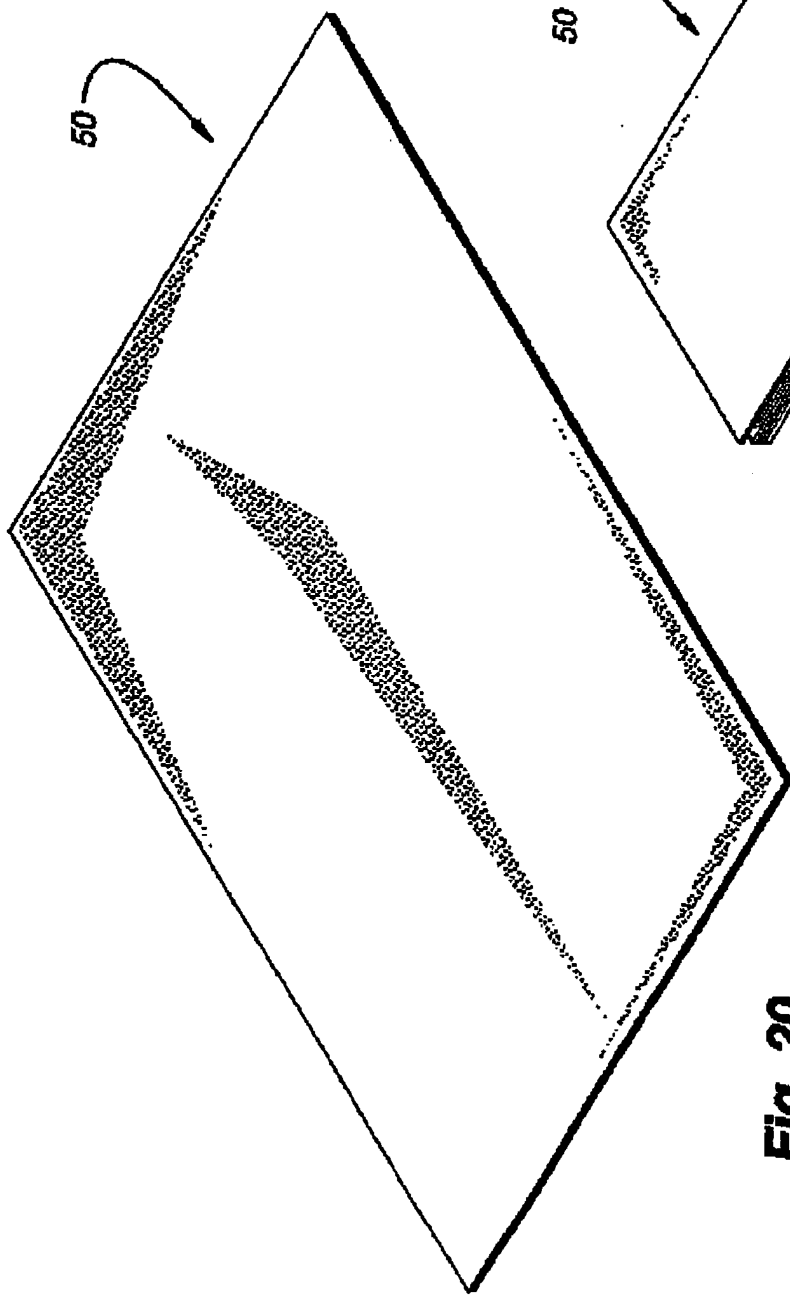

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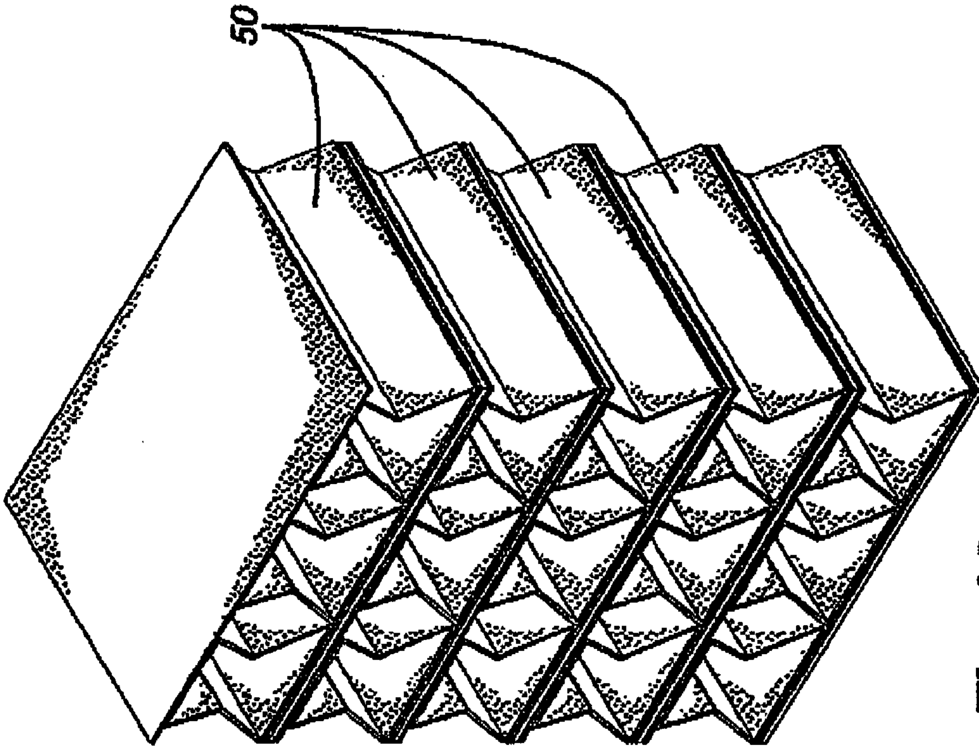

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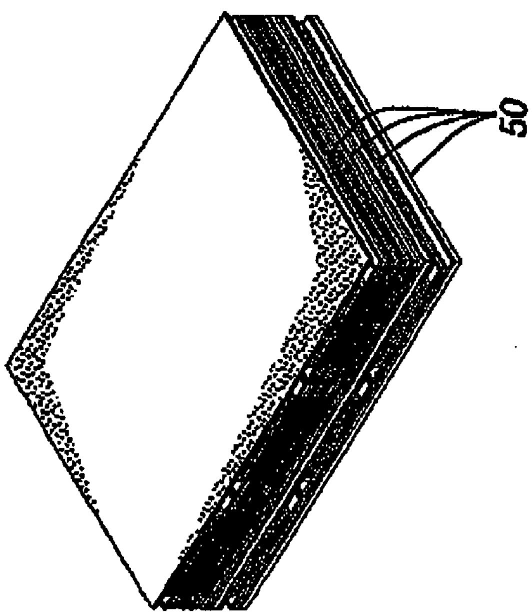


Fig. 22

PAGE 33/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

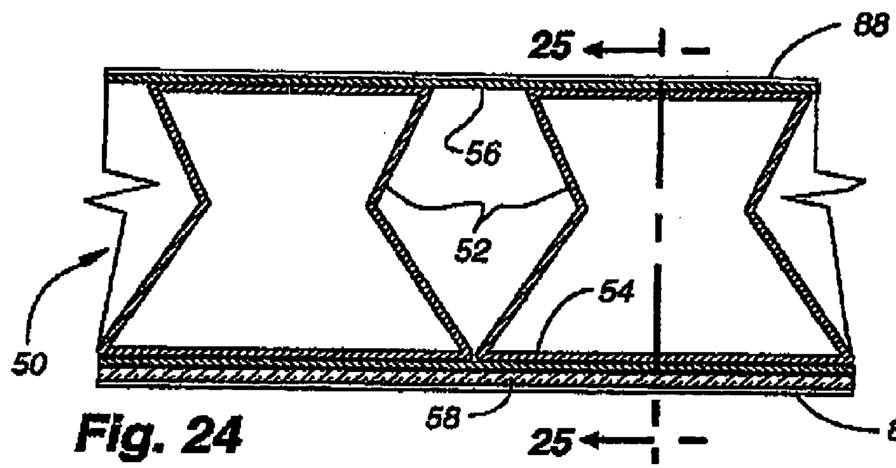
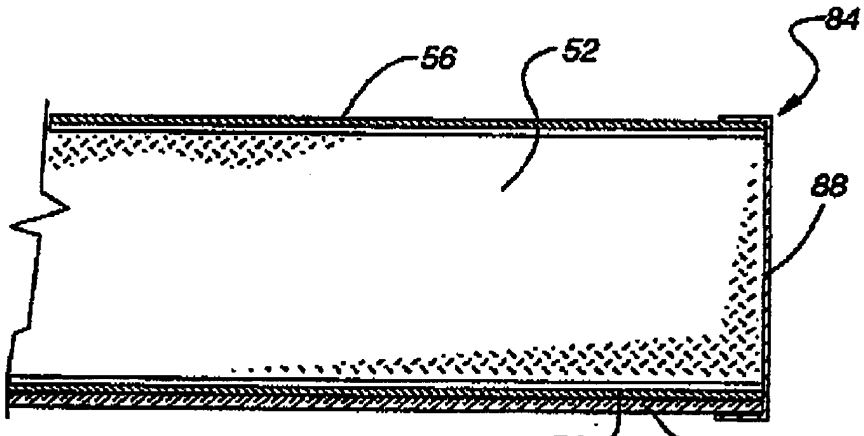


Fig. 24



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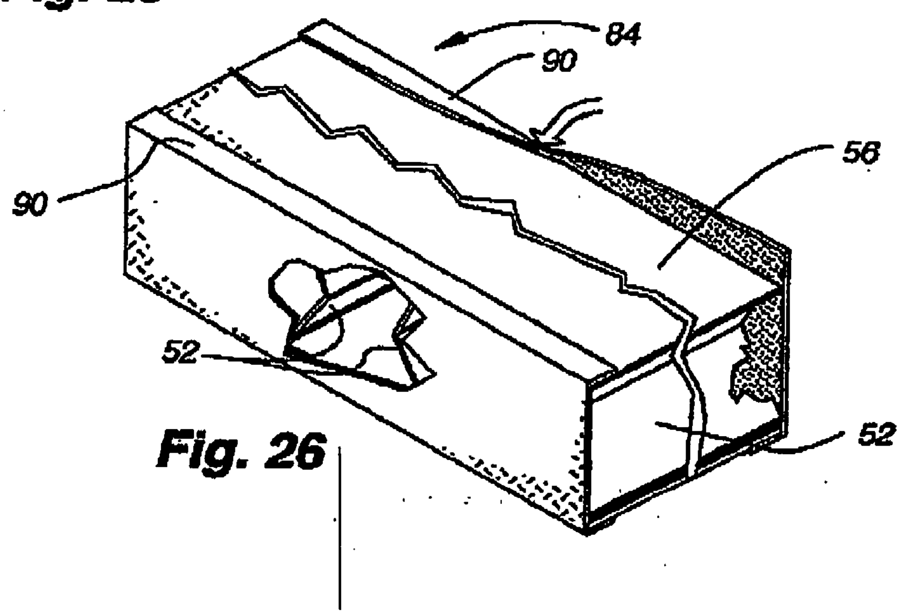


Fig. 26

10/21/2008 11:35 3039782323 PAGE 35/91

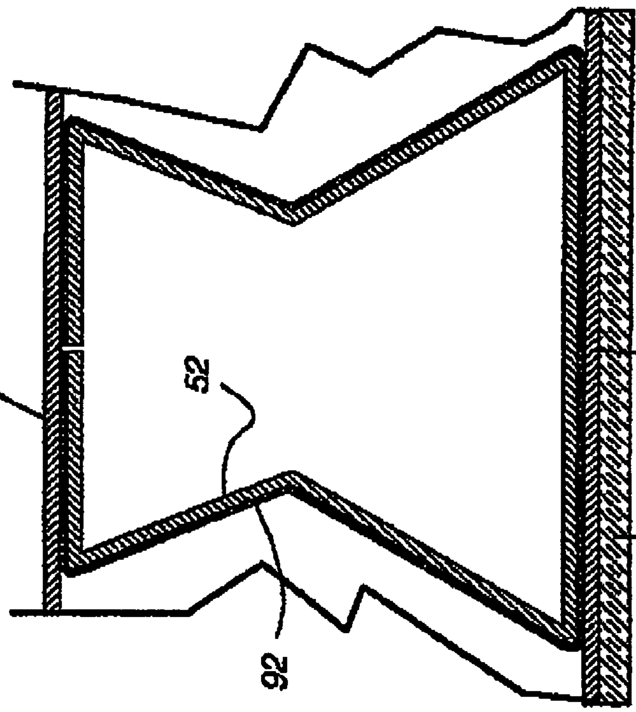


Fig. 28

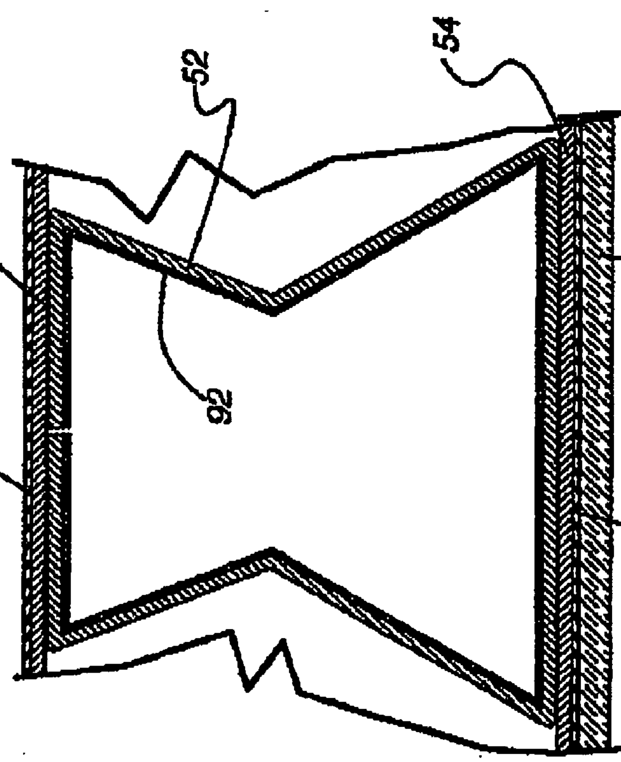


Fig. 27

PAGE 35/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

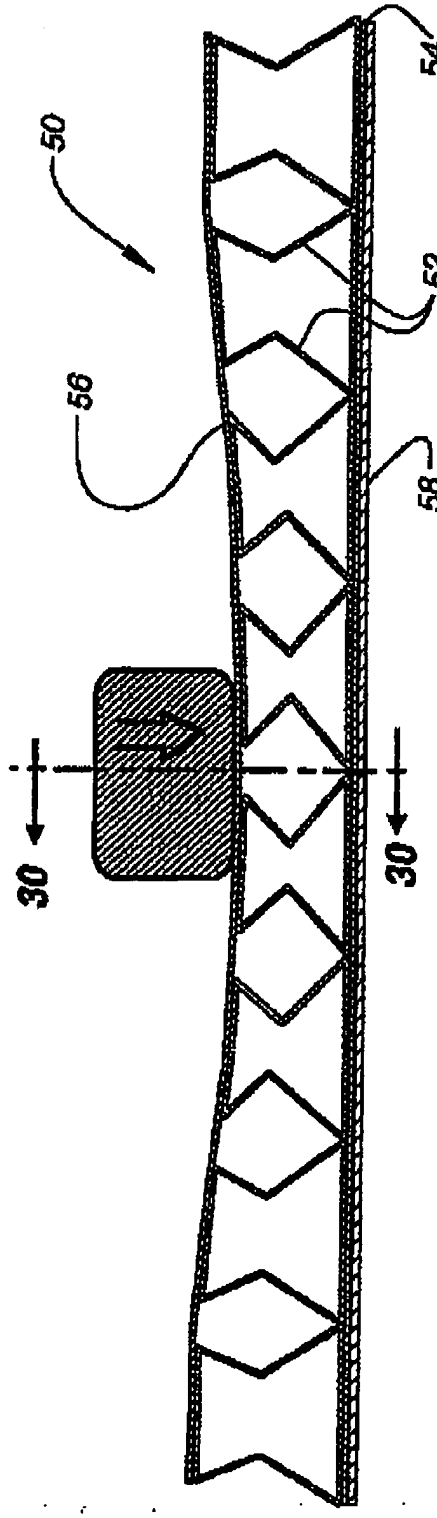


Fig. 29

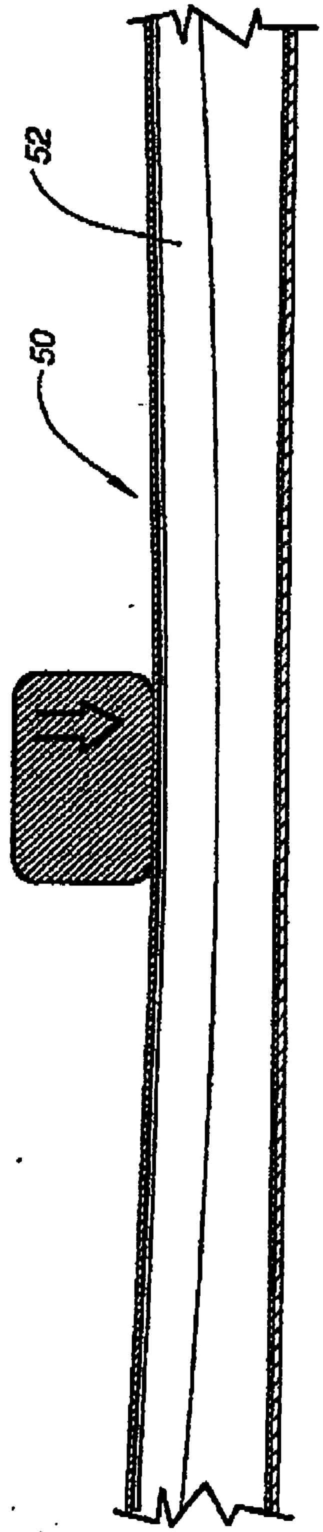


Fig. 30

Patent Application Publication Feb. 21, 2002 Sheet 12 of 42 US 2002/0020142 A1

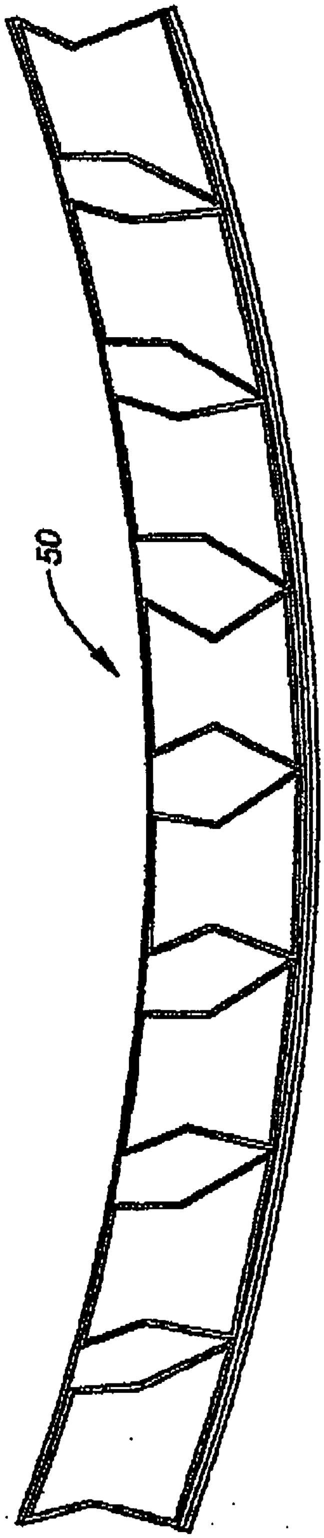


Fig. 31

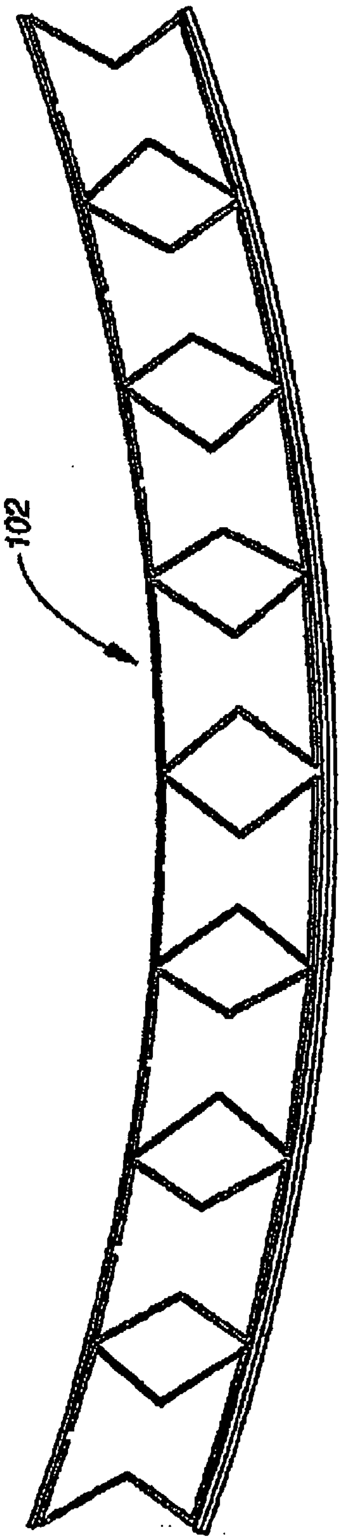


Fig. 32

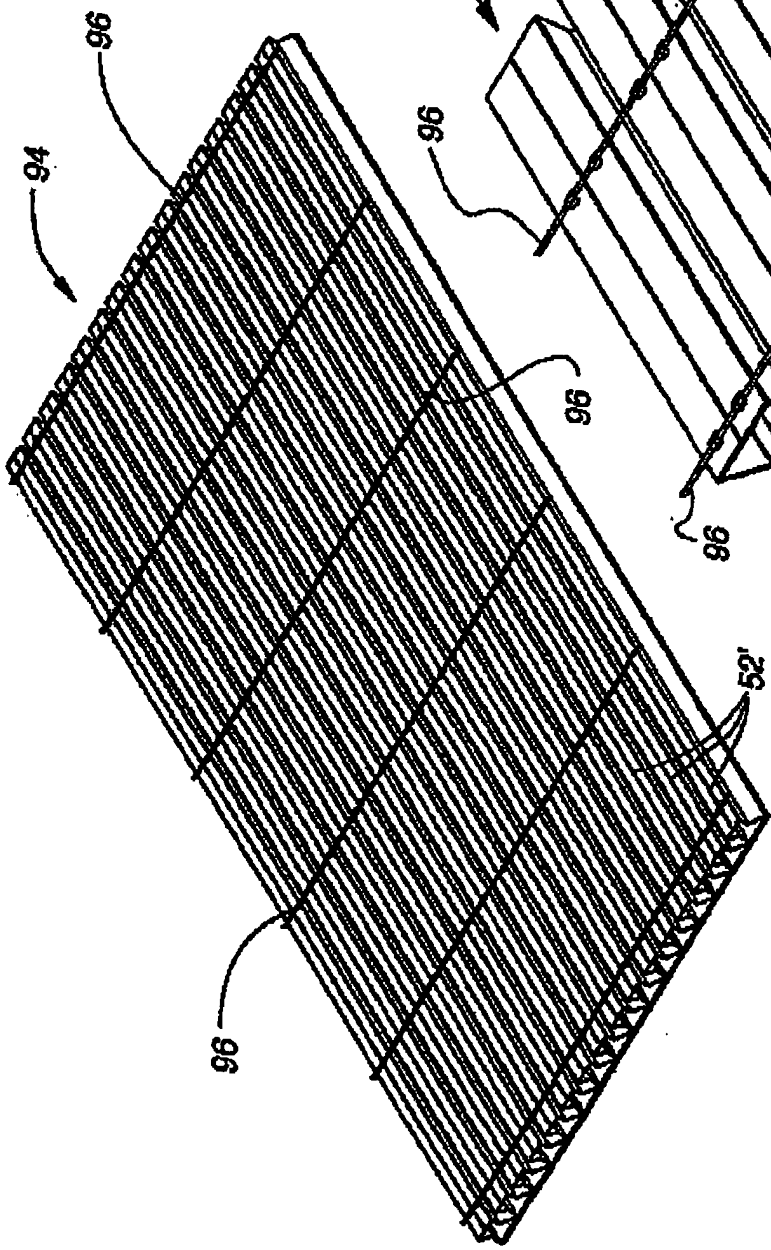


Fig. 33

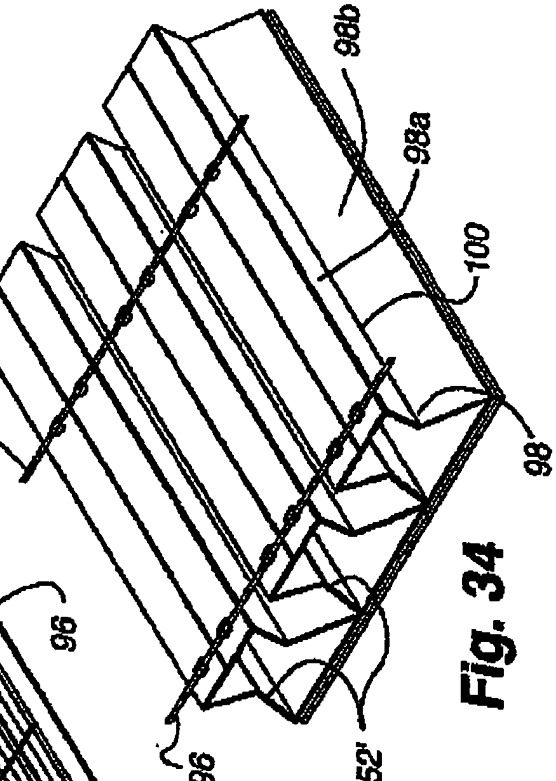


Fig. 34

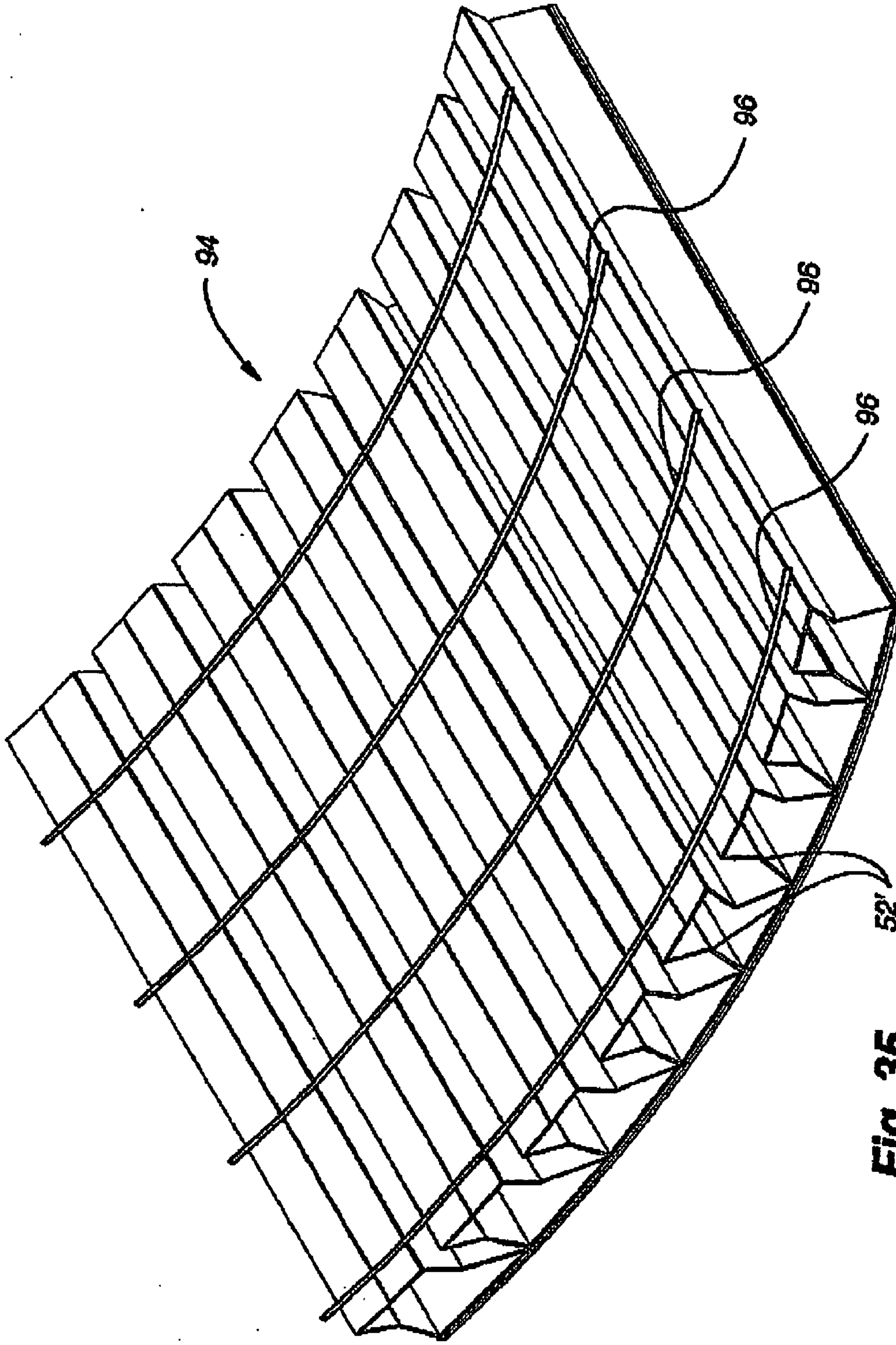
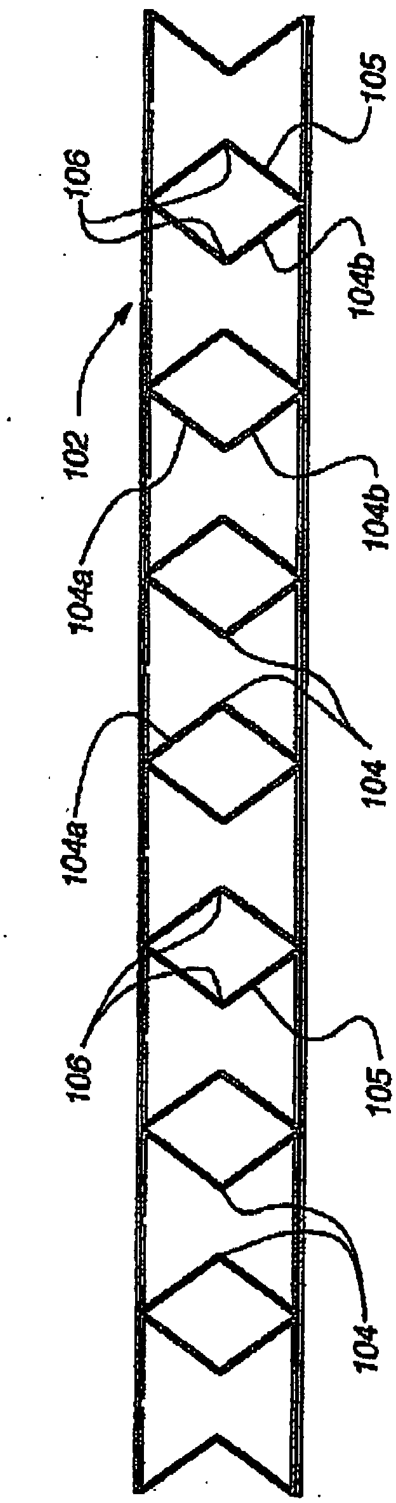


Fig. 35



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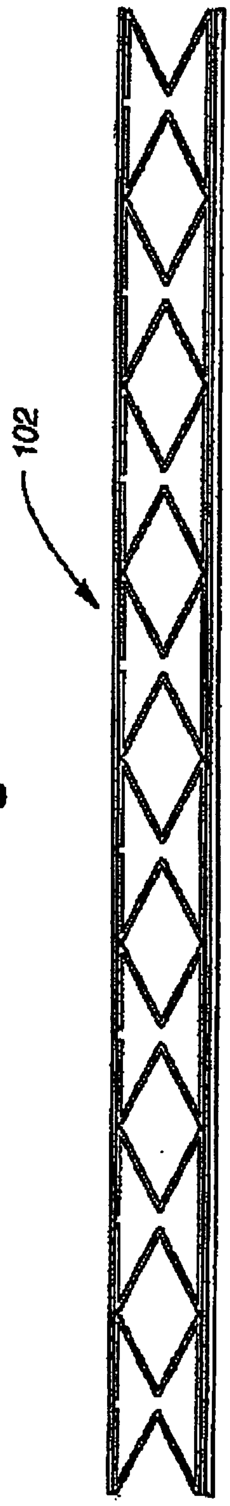

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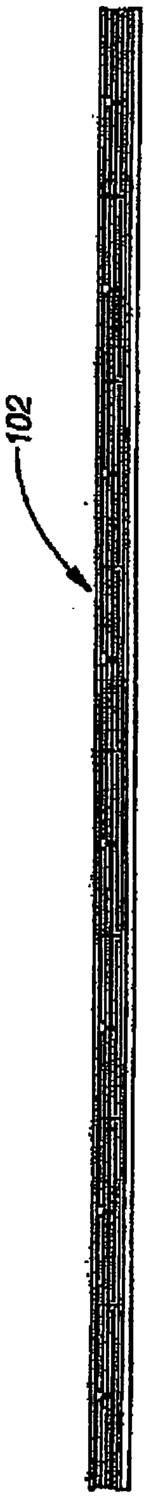

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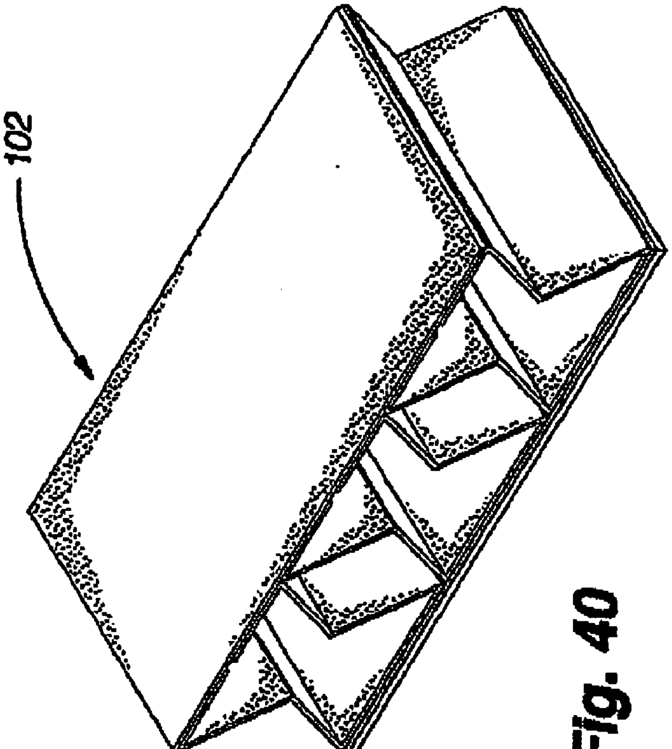
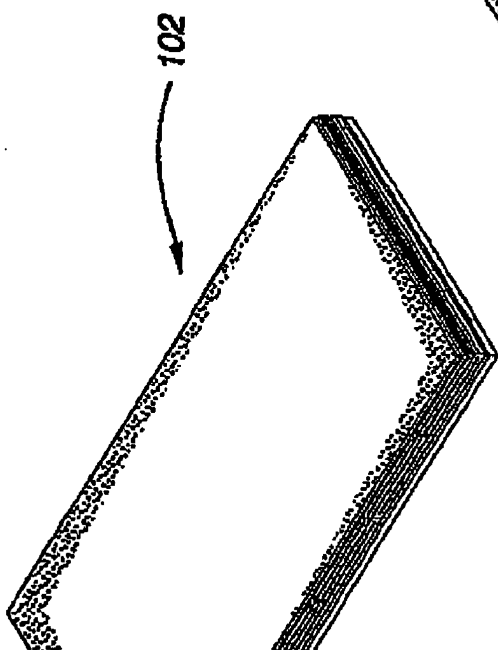


Fig. 40



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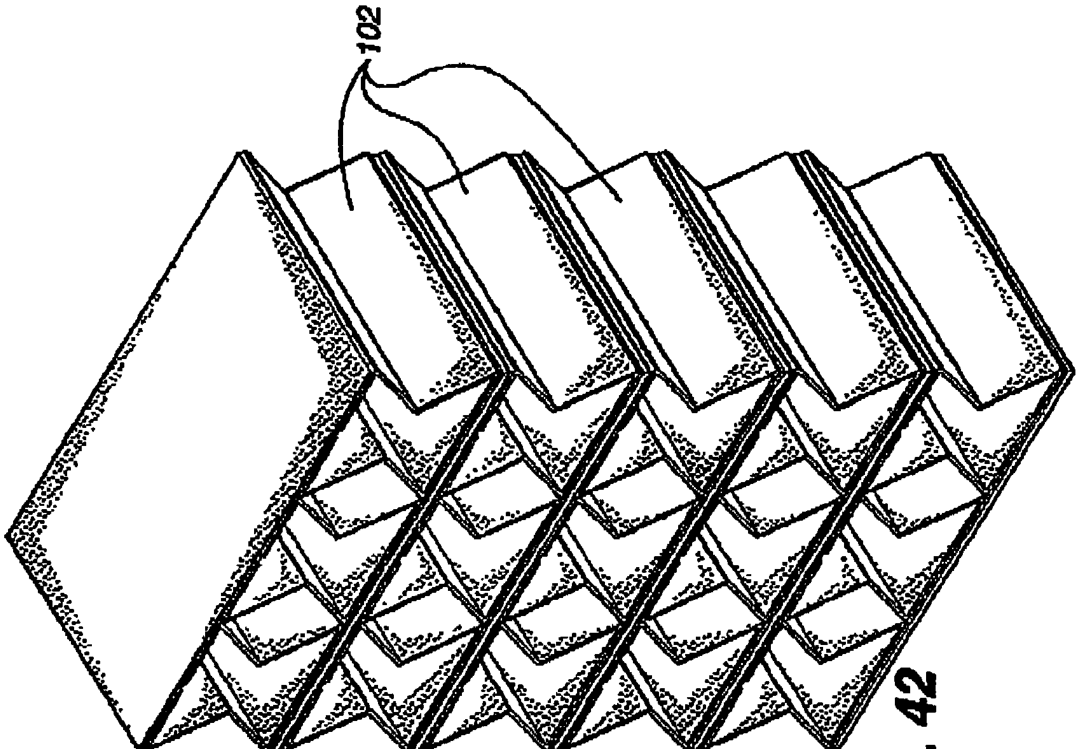


Fig. 42

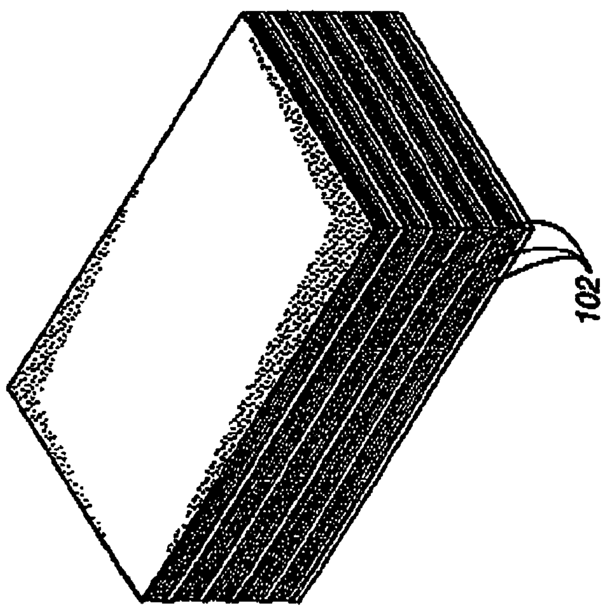


Fig. 41

Patent Application Publication Feb. 21, 2002 Sheet 18 of 42 US 2002/0020142 A1

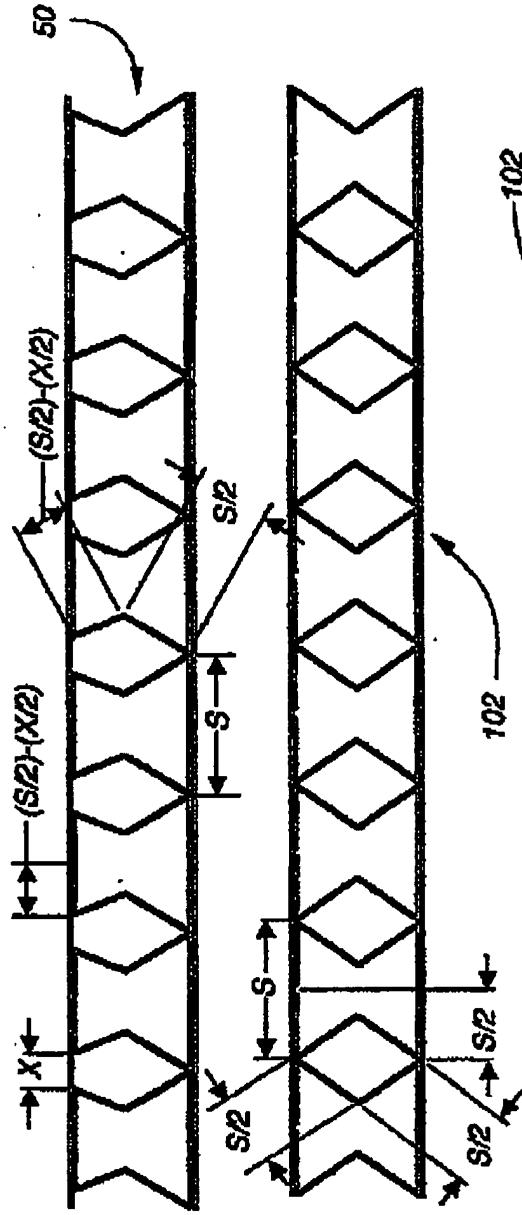


Fig. 43

Fig. 44

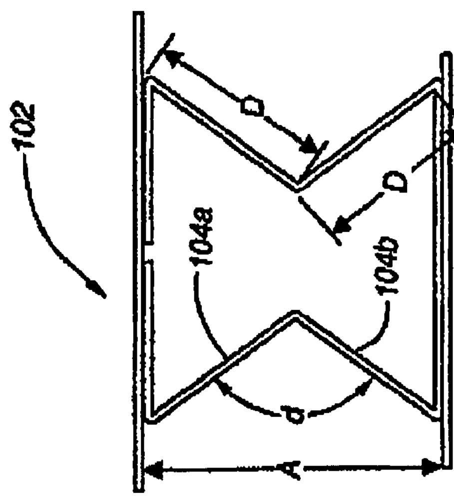
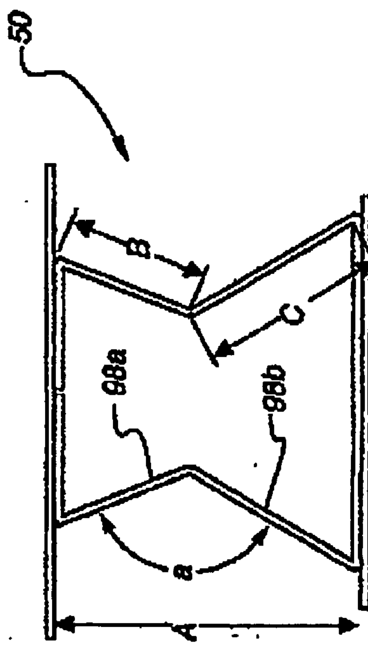


Fig. 46



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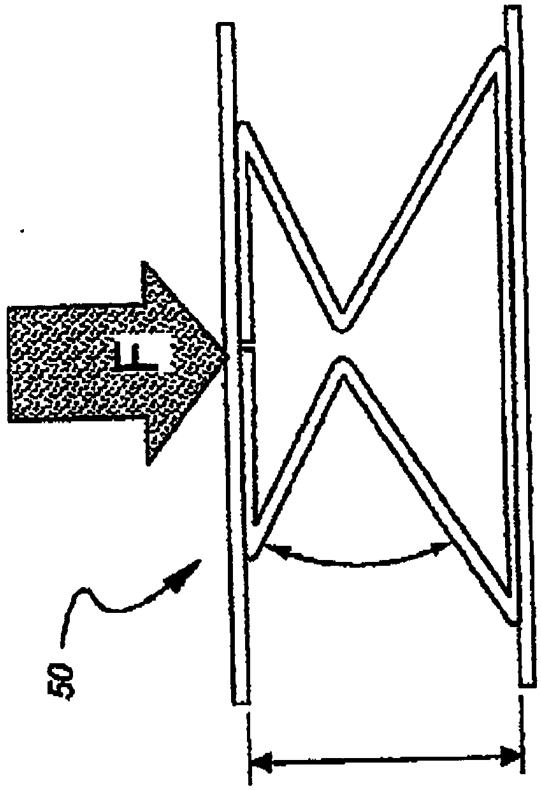

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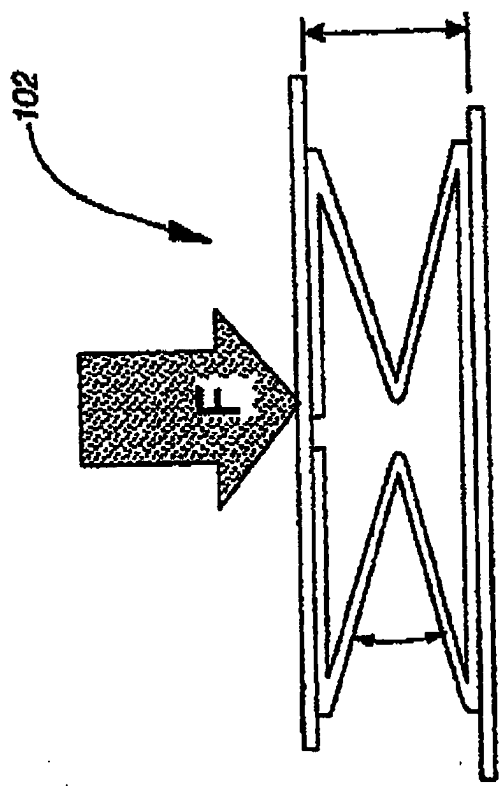


Fig. 48

Patent Application Publication Feb. 21, 2002 Sheet 20 of 42 US 2002/0020142 A1

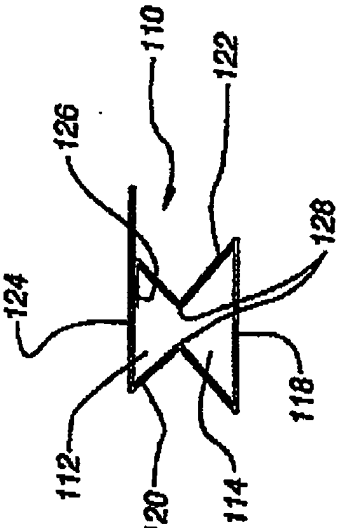


Fig. 50

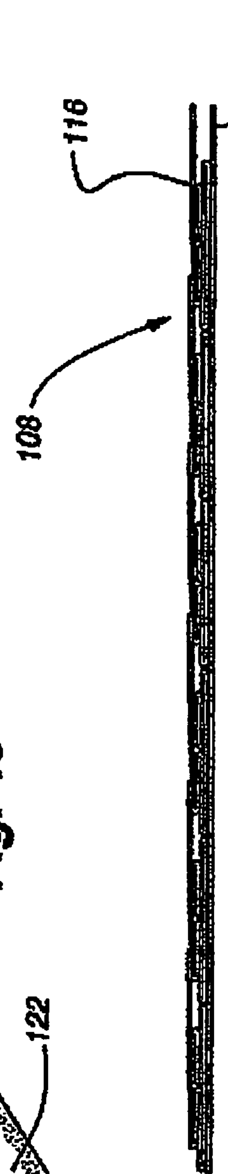


Fig. 52

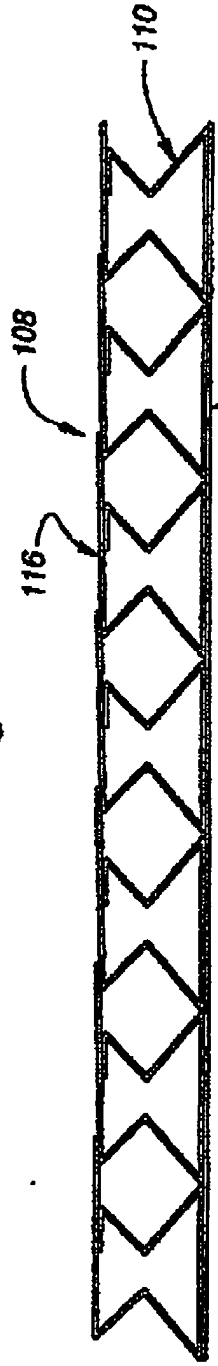


Fig. 51

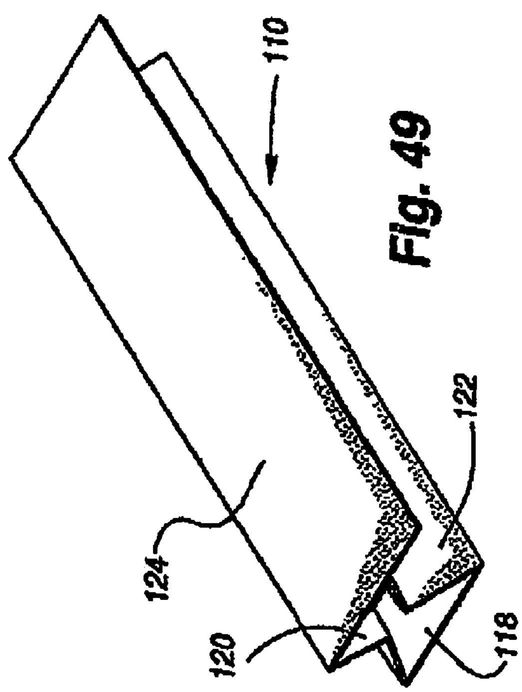
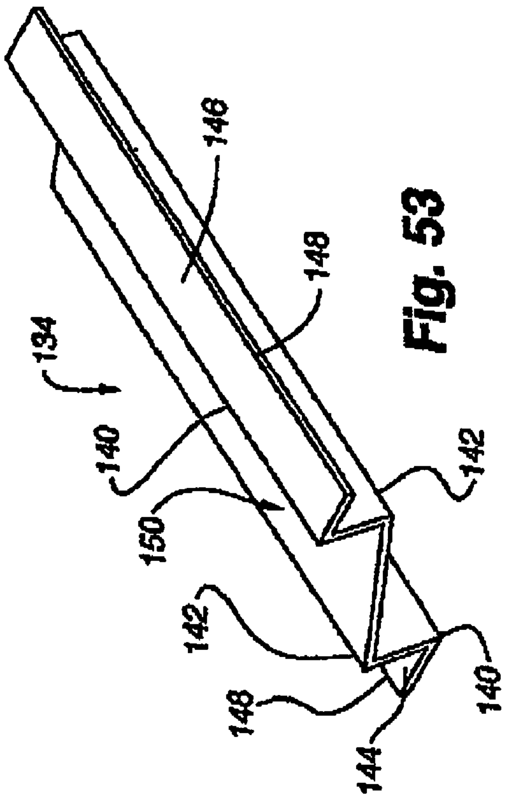


Fig. 49

PAGE 45/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



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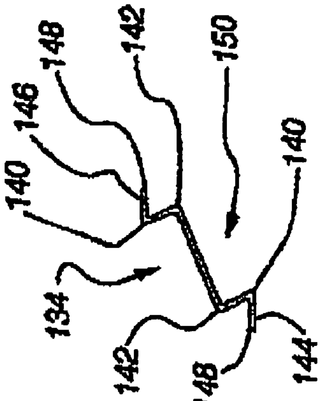

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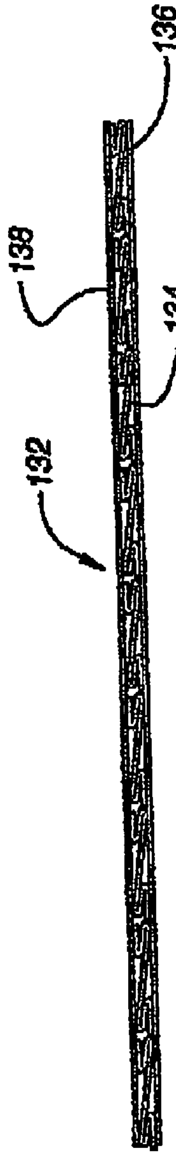

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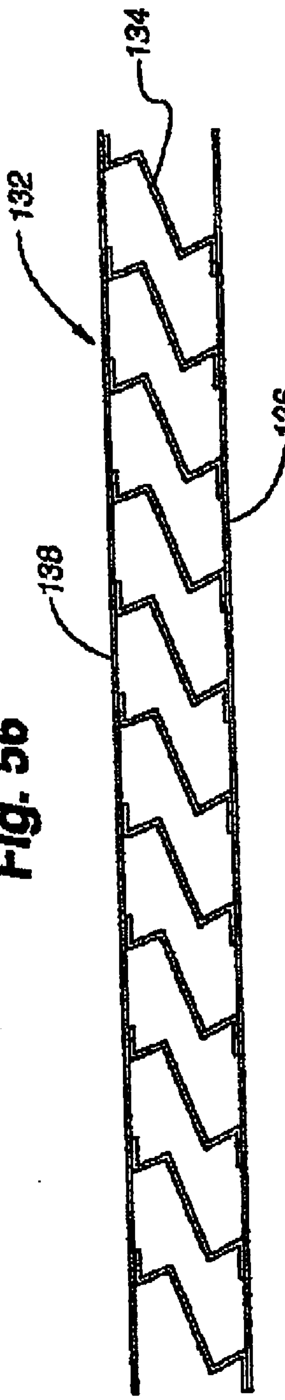


Fig. 55

PAGE 46/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

Patent Application Publication Feb. 21, 2002 Sheet 22 of 42 US 2002/0020142 A1

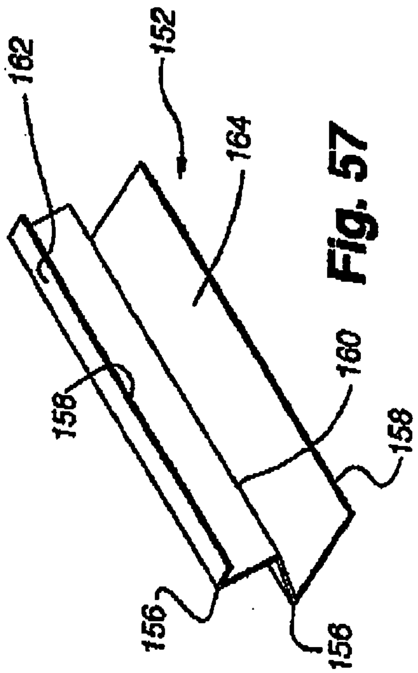


Fig. 57

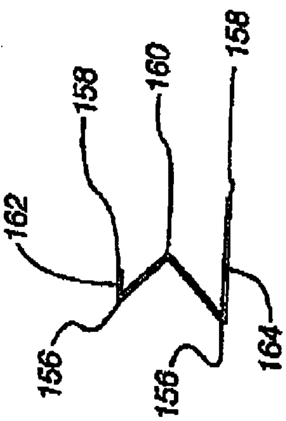


Fig. 58

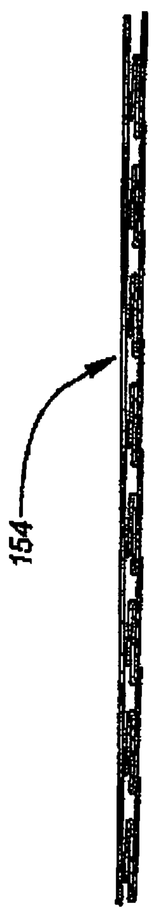


Fig. 60

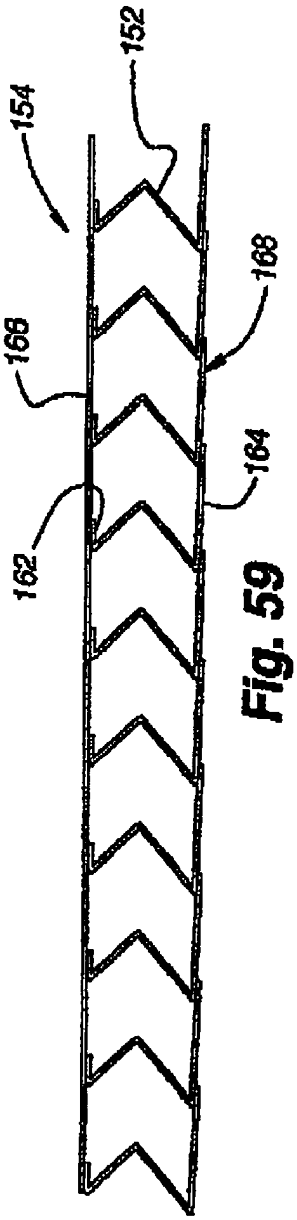
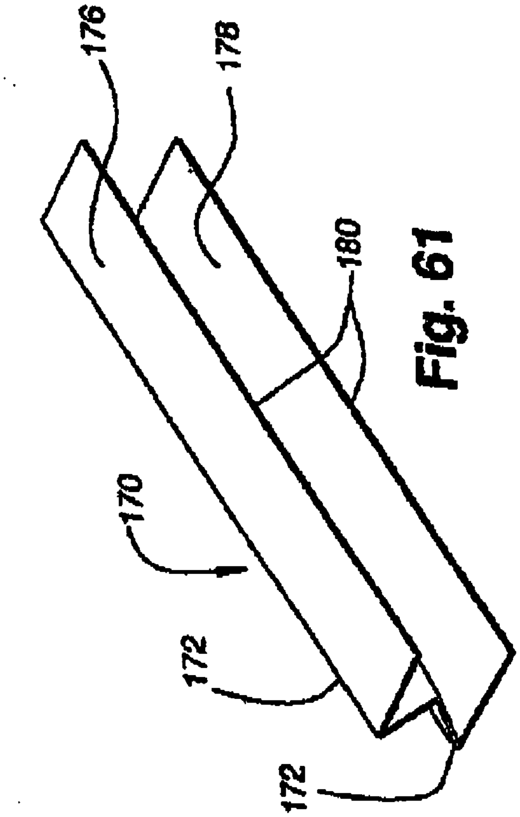


Fig. 59



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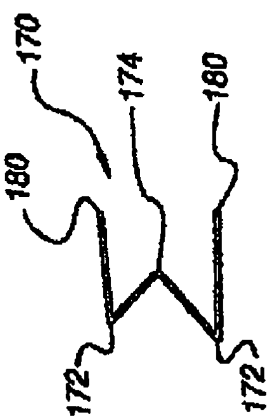

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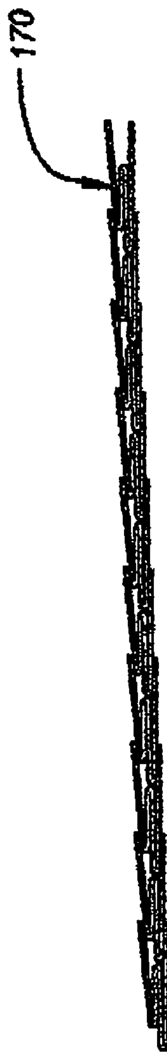

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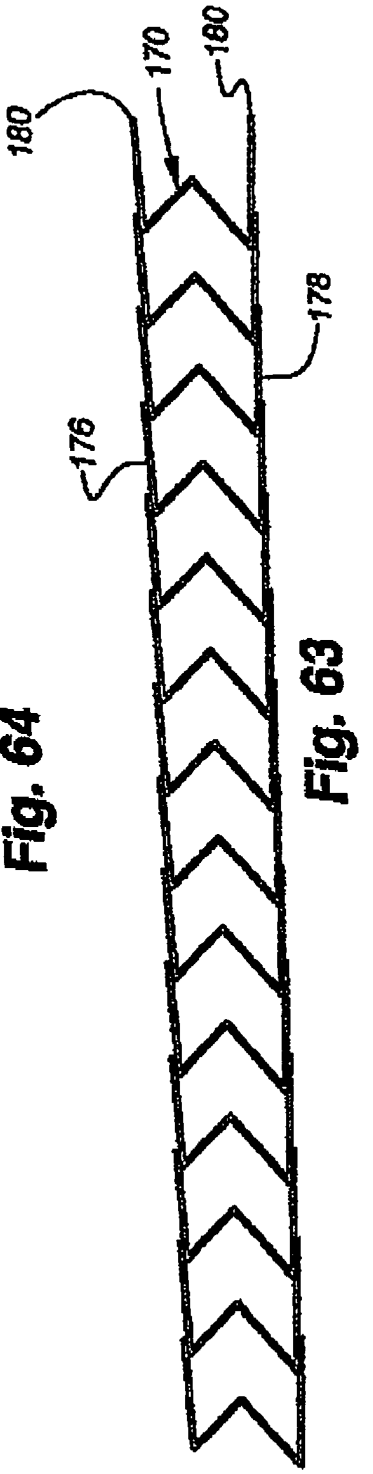

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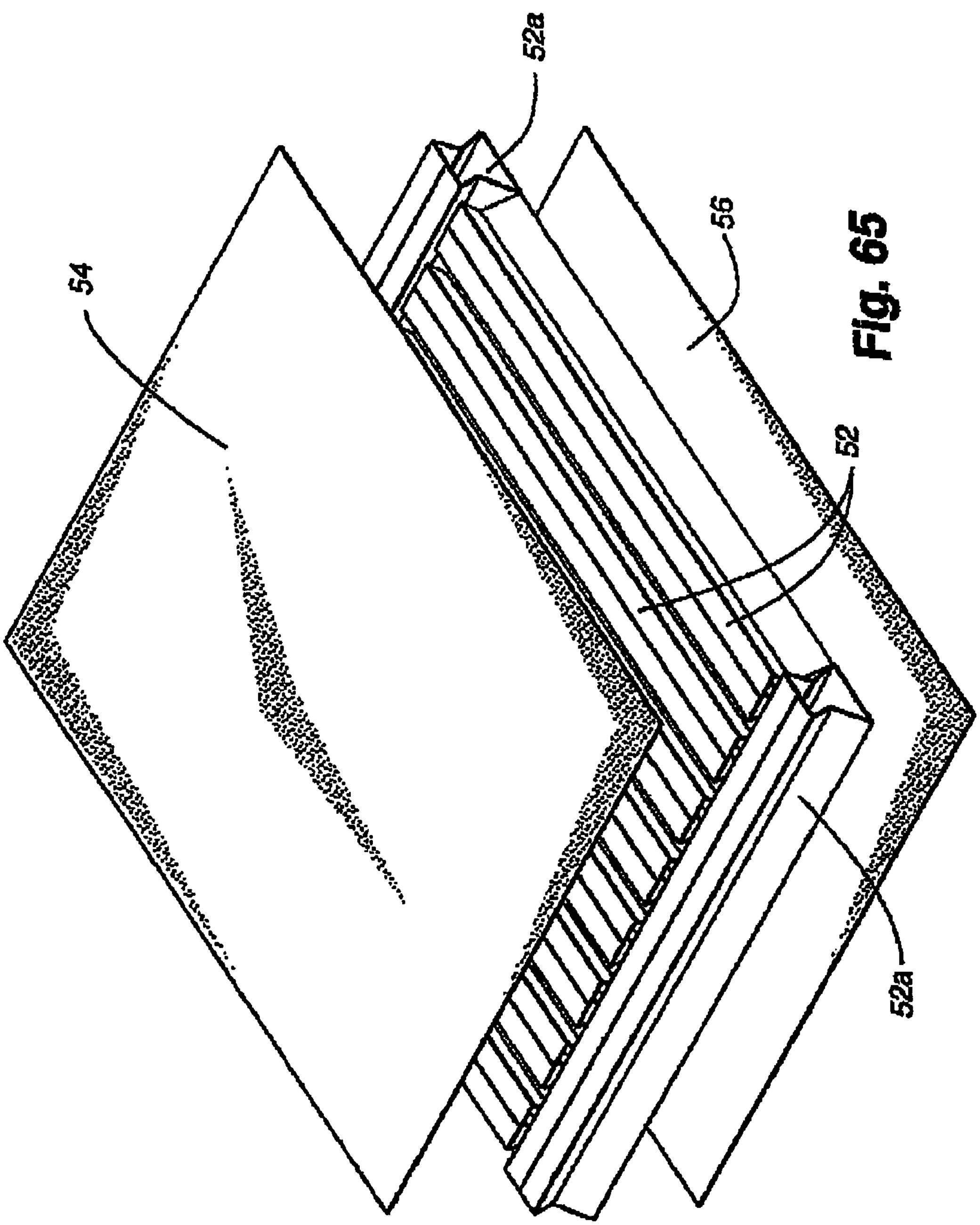
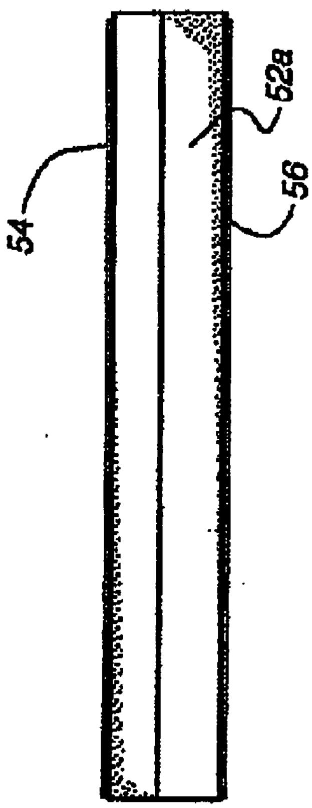


Fig. 65

PAGE 49/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



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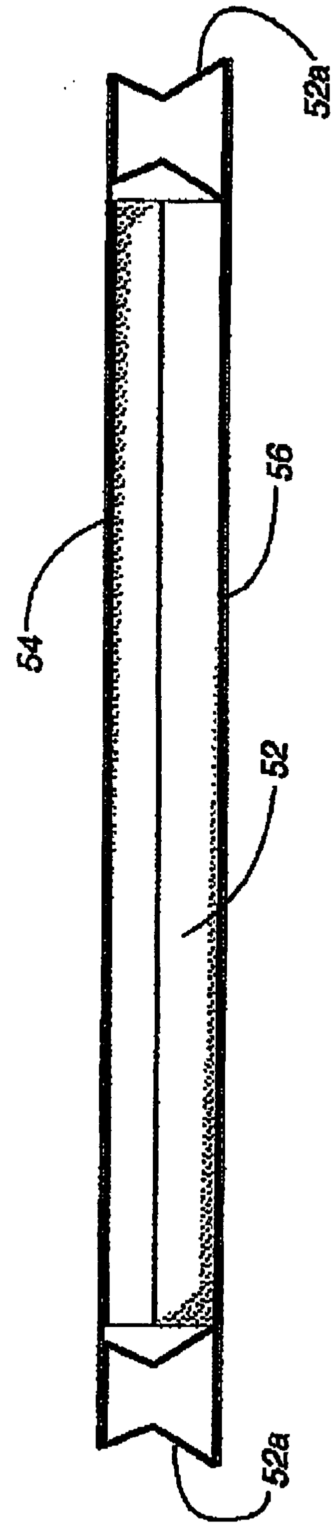

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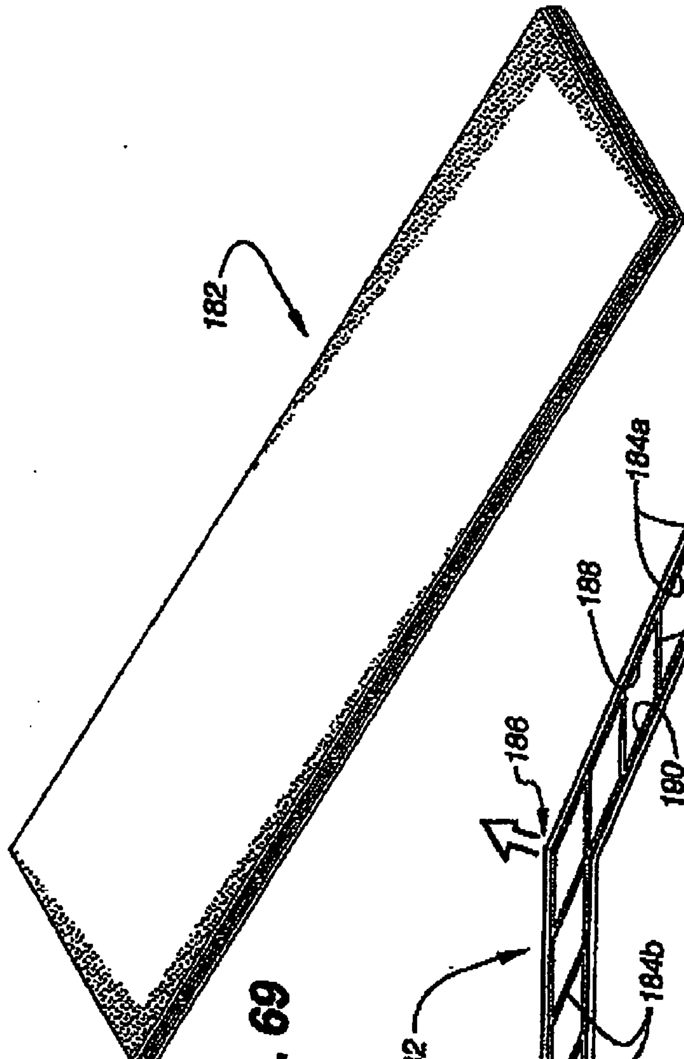


Fig. 69

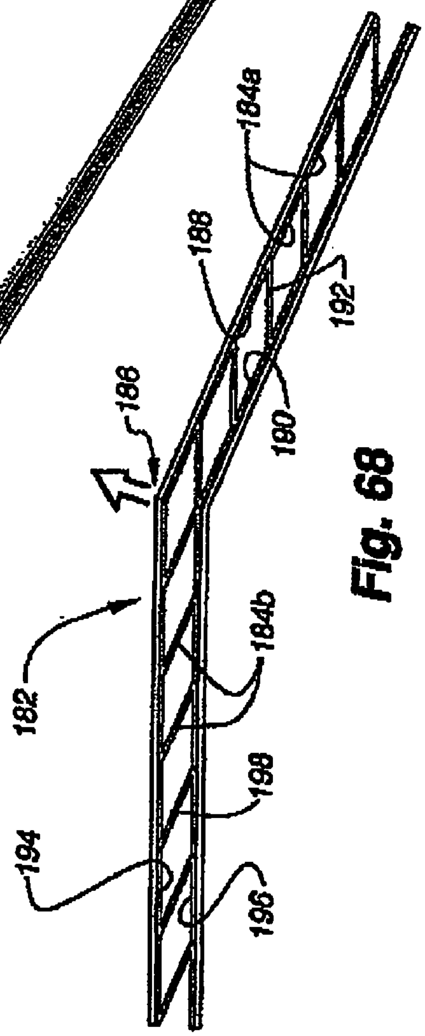


Fig. 68

Fig. 70

PAGE 51/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

Patent Application Publication Feb. 21, 2002 Sheet 27 of 42 US 2002/0020142 A1

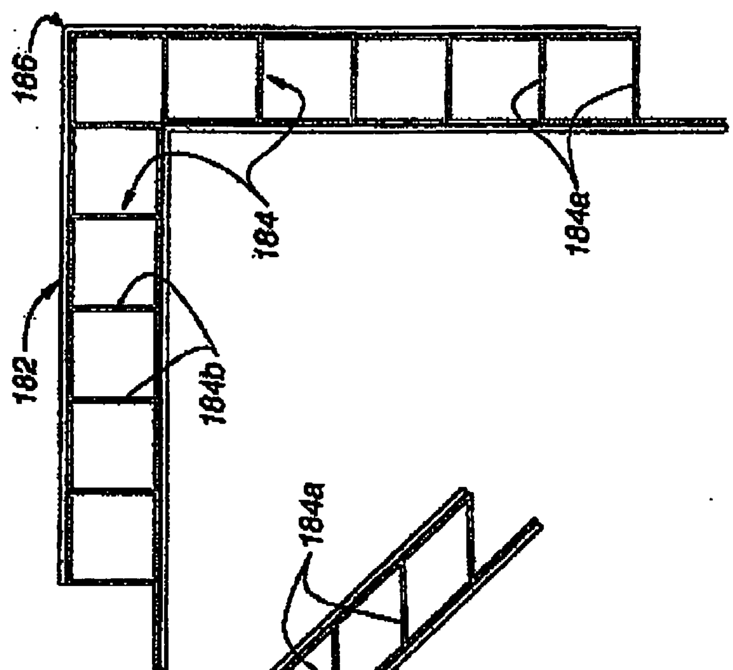
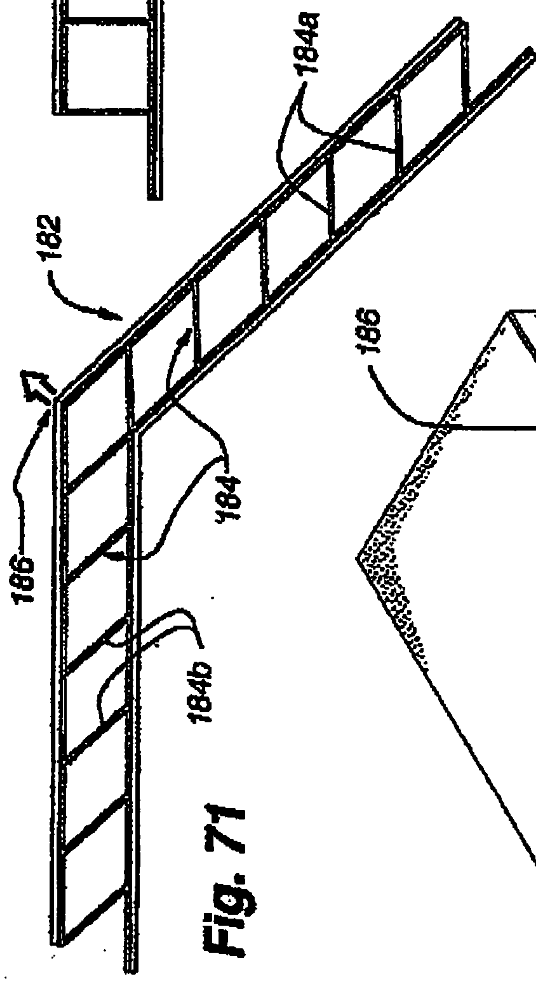


Fig. 73



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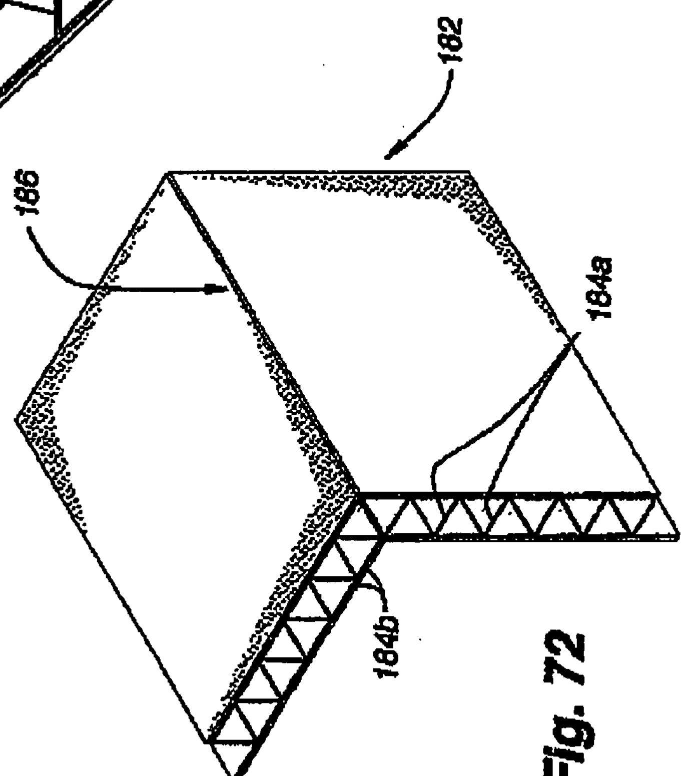
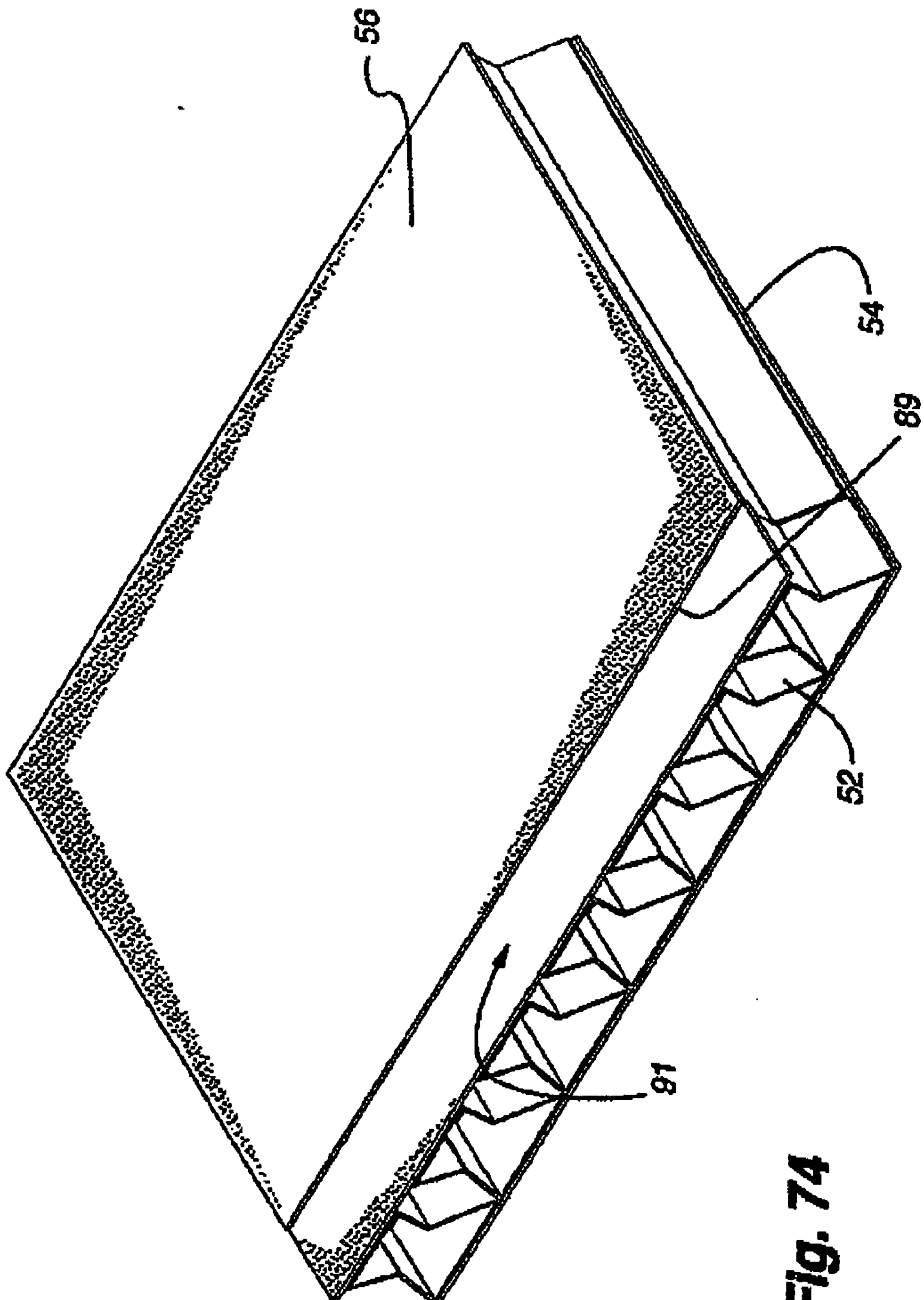


Fig. 72

PAGE 52/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



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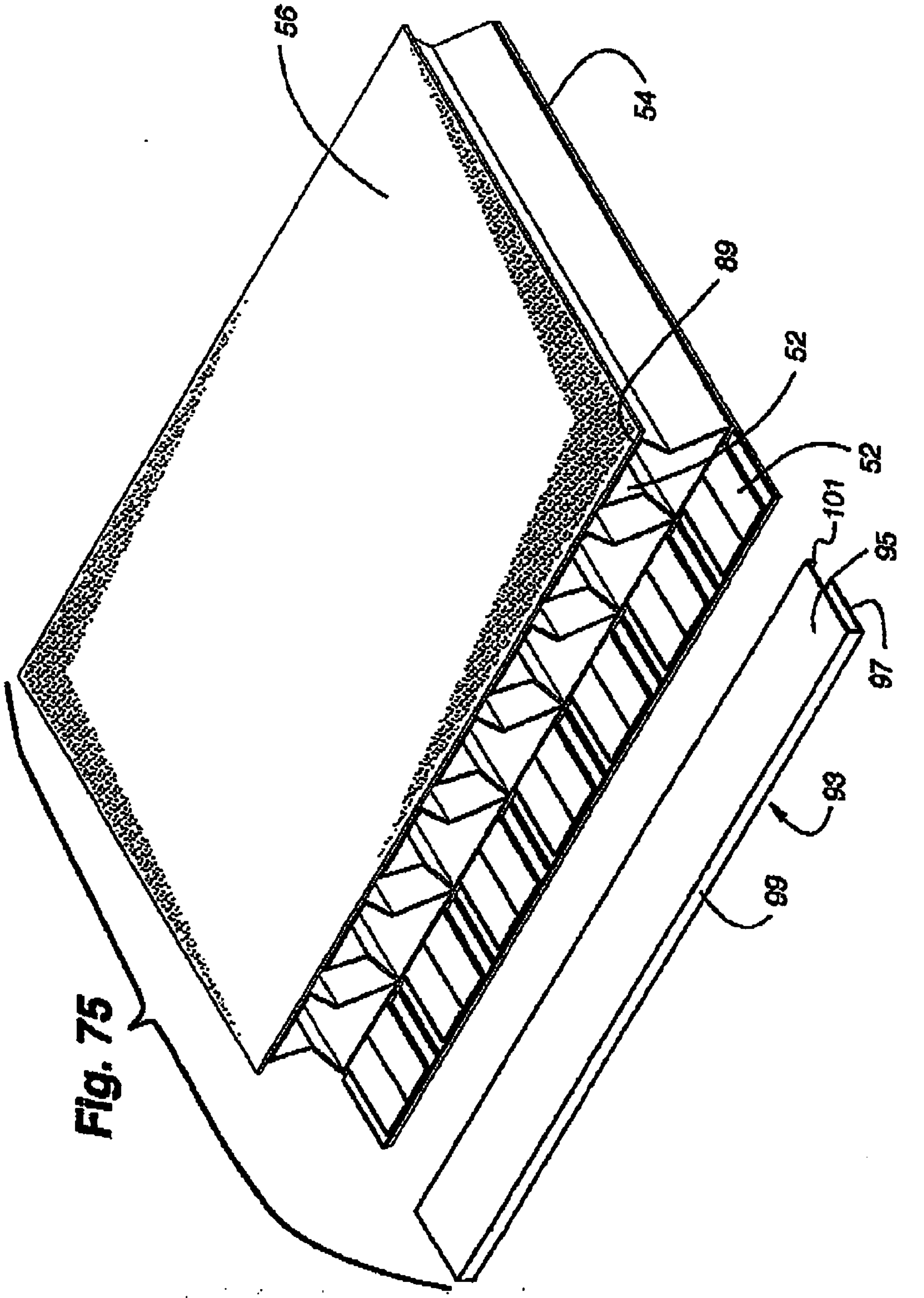

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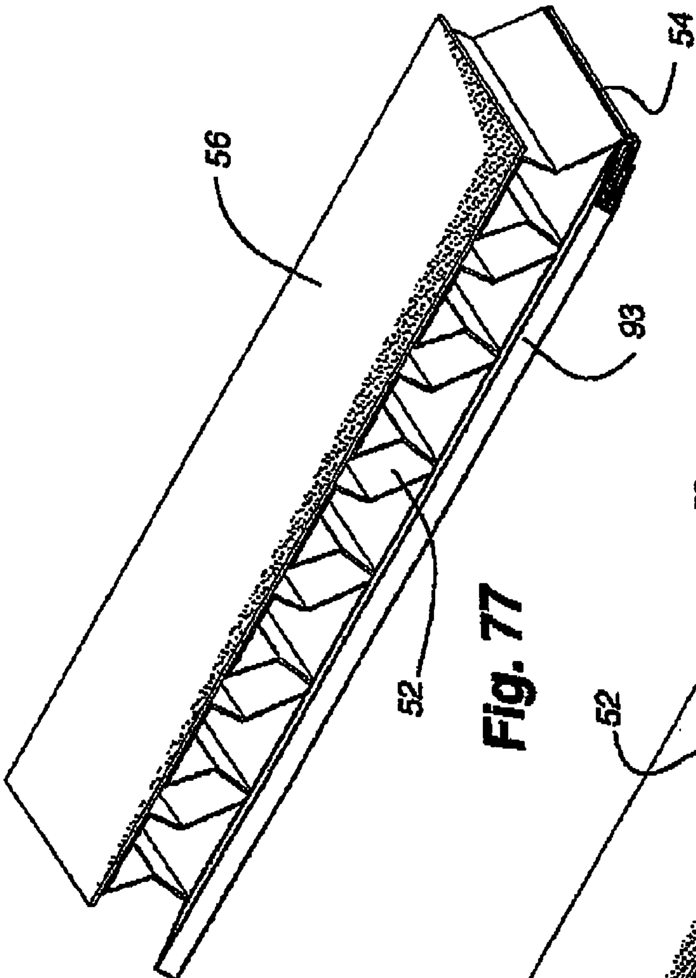

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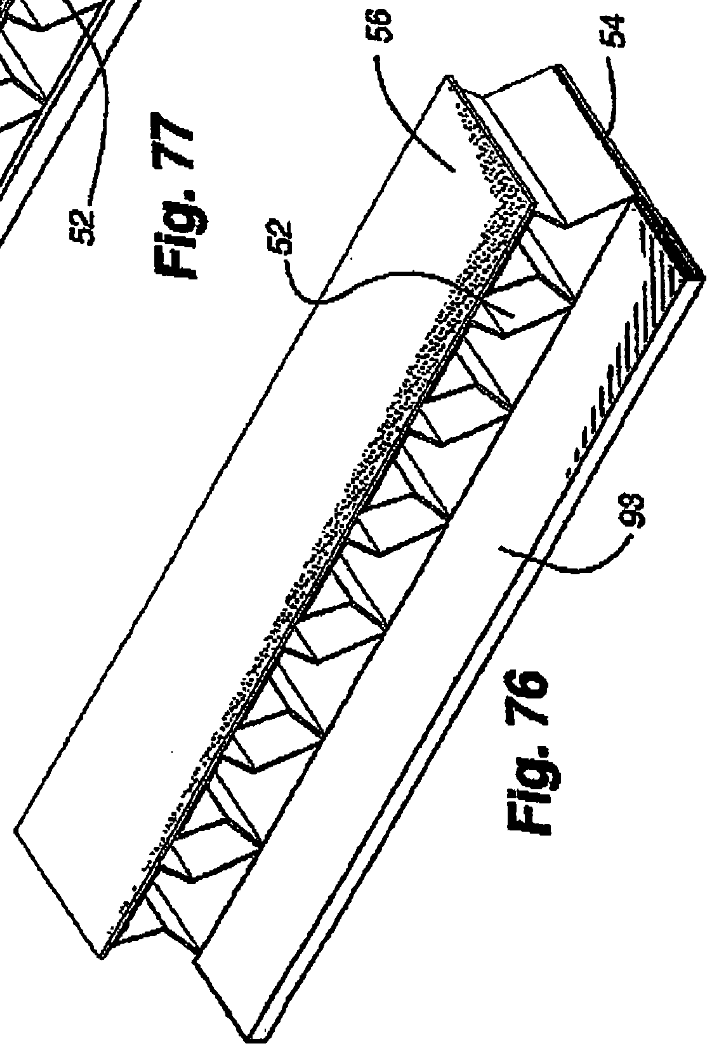

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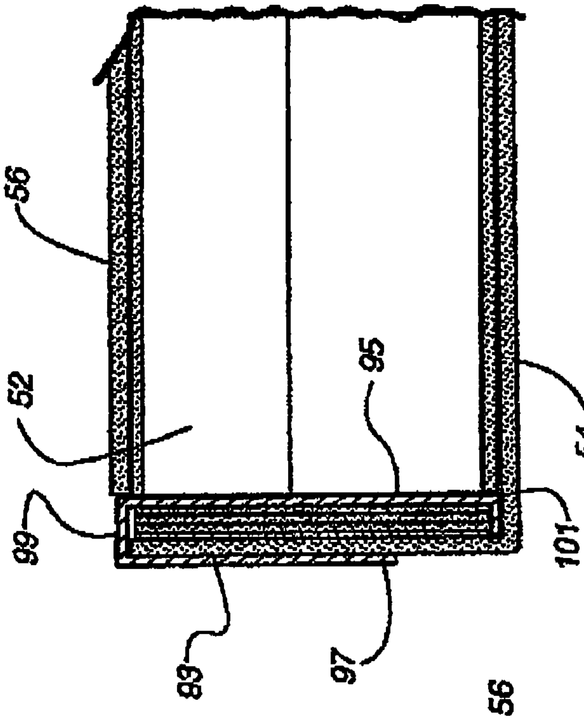

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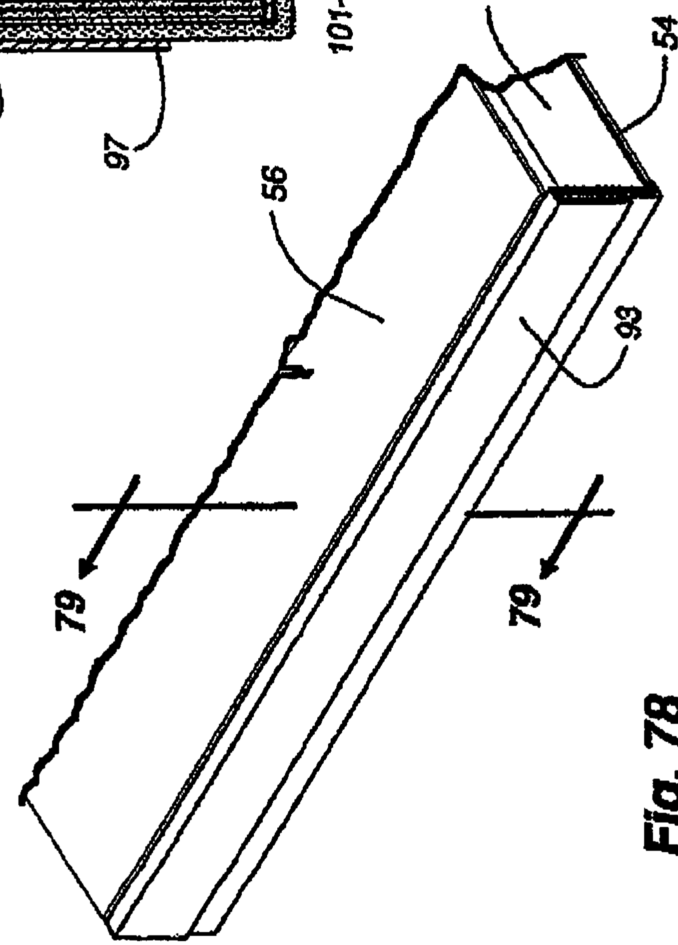

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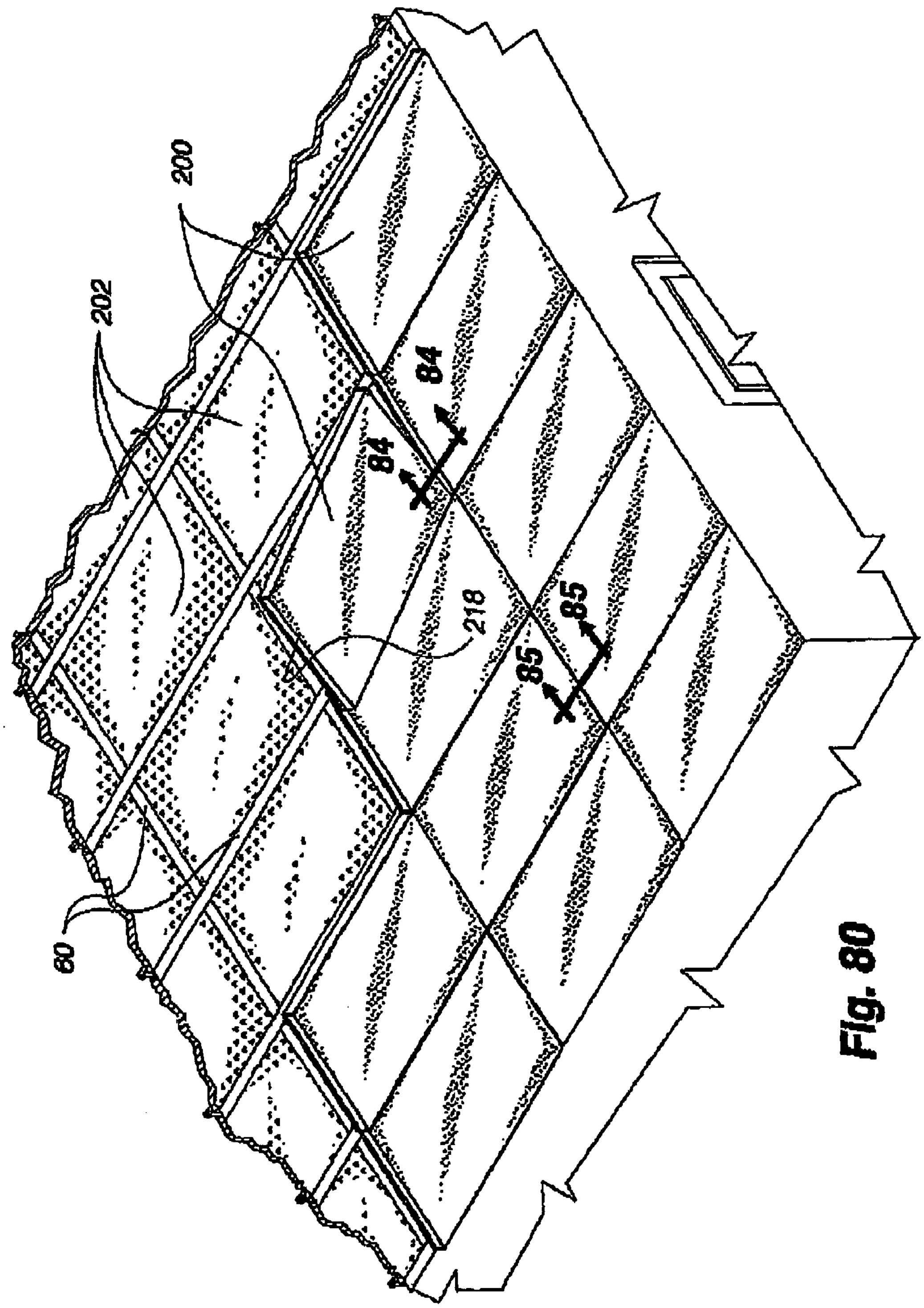
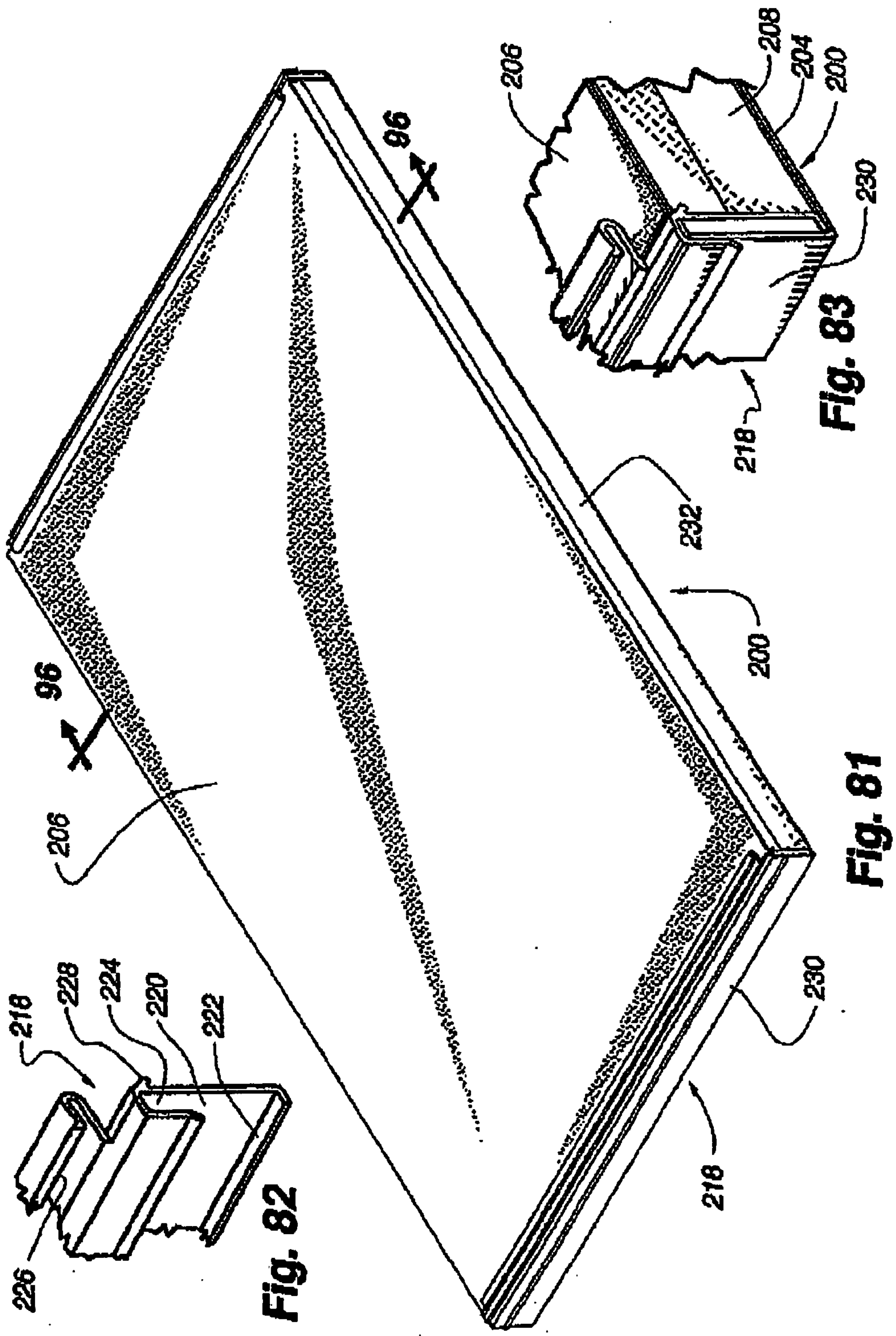
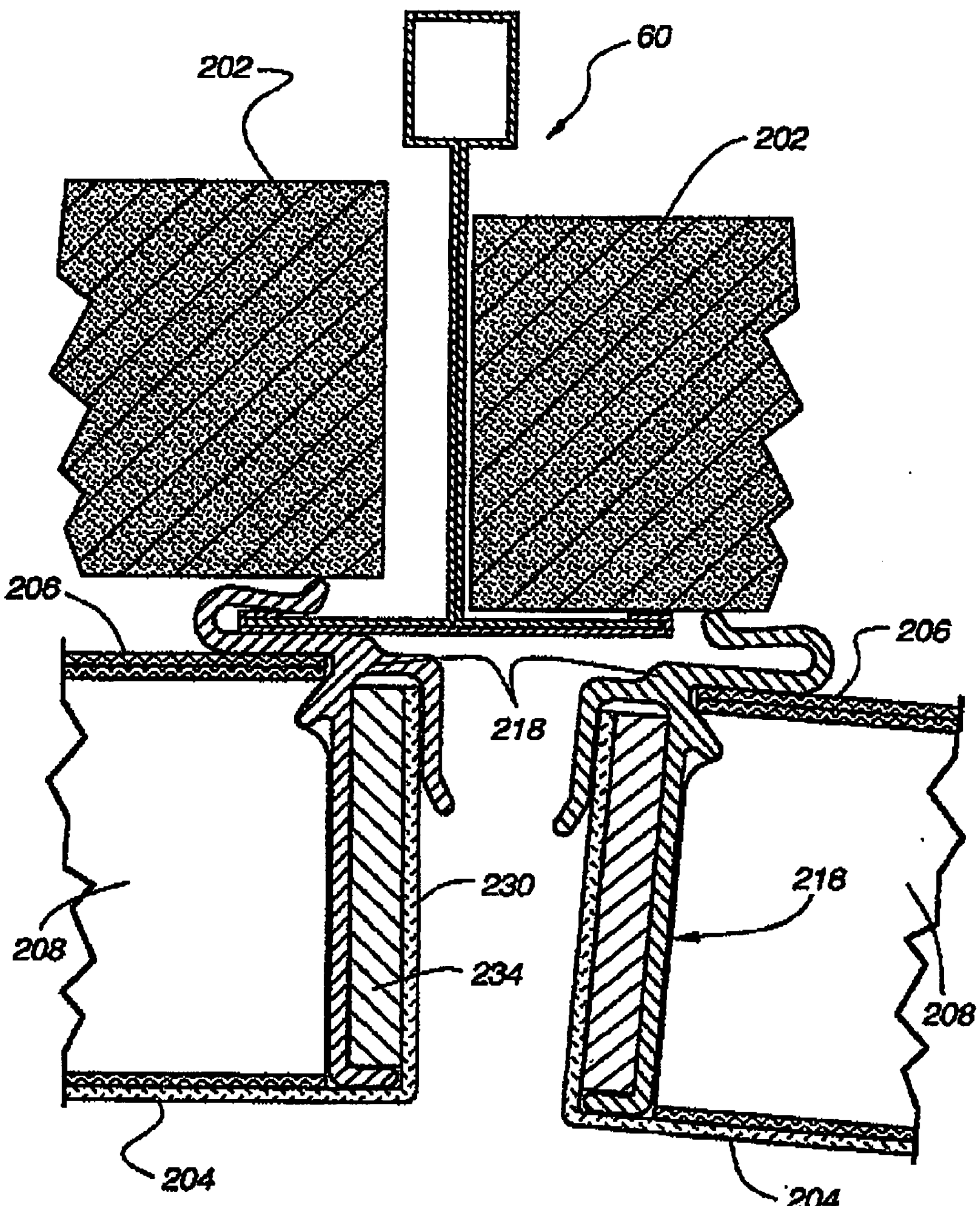


Fig. 80

PAGE 57/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



PAGE 58/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10



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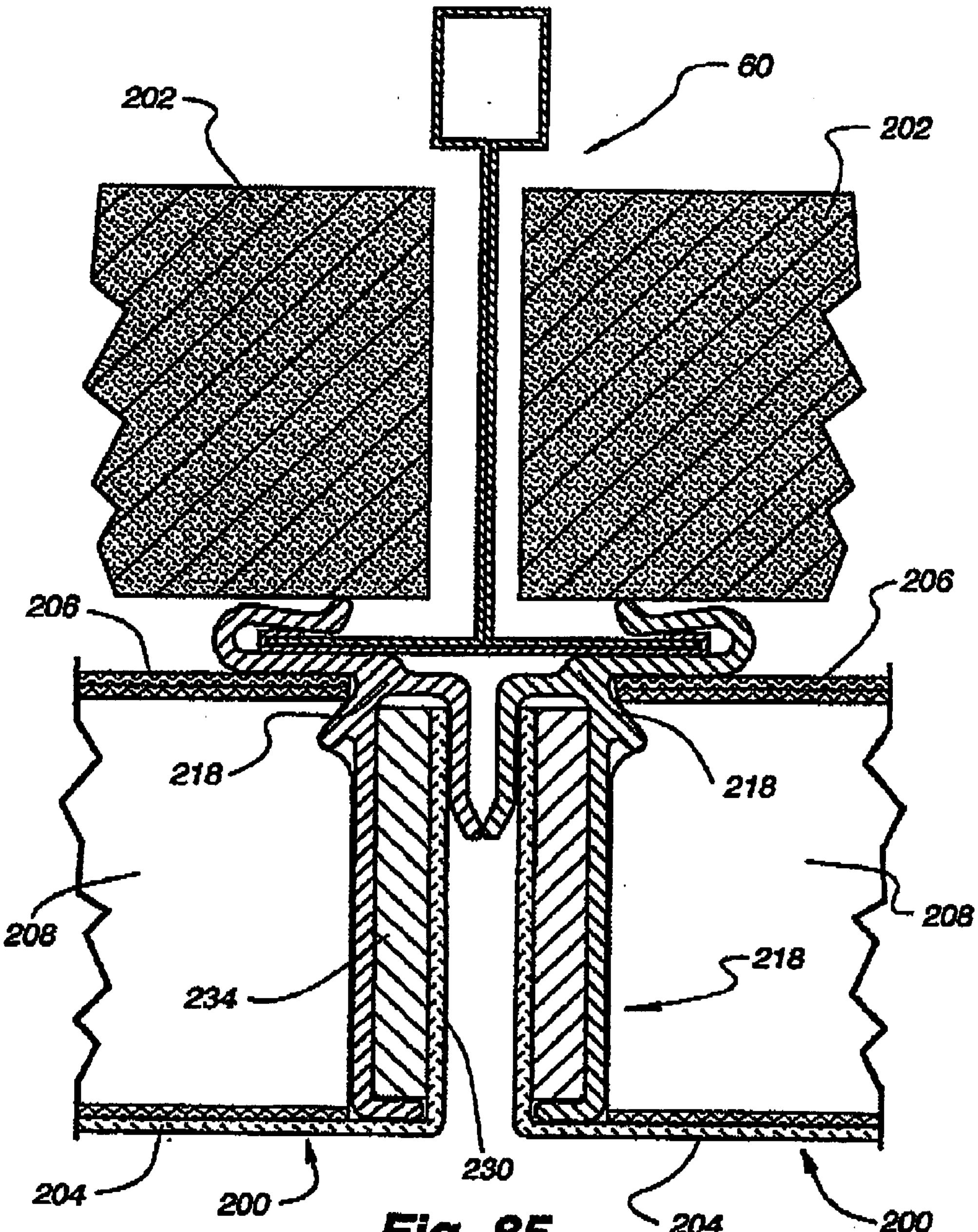

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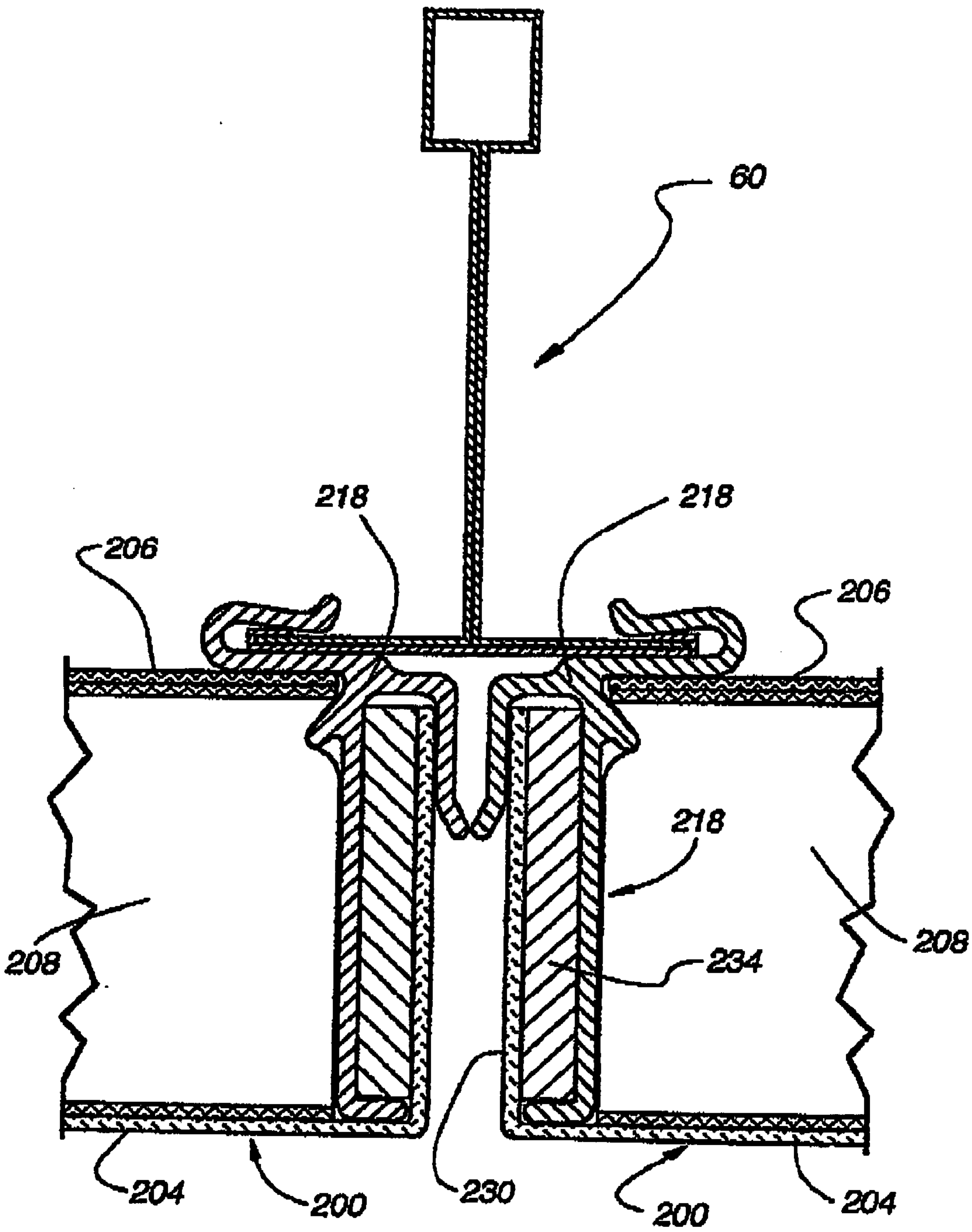

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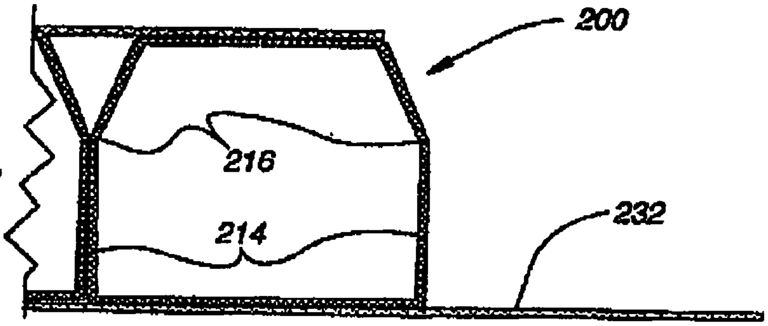

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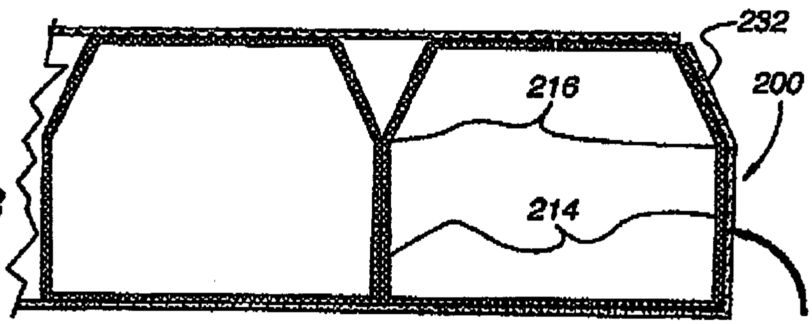


Fig. 88

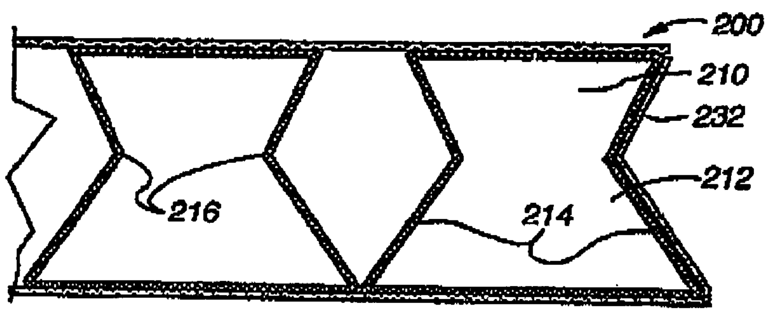


Fig. 89

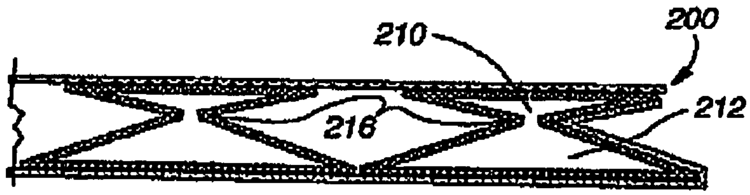


Fig. 90

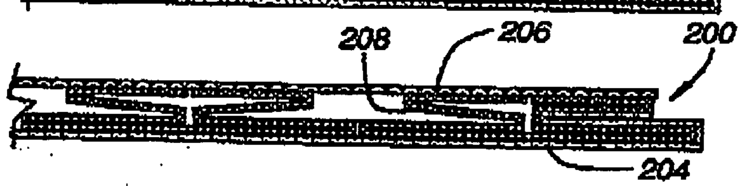


Fig. 91

Fig. 92

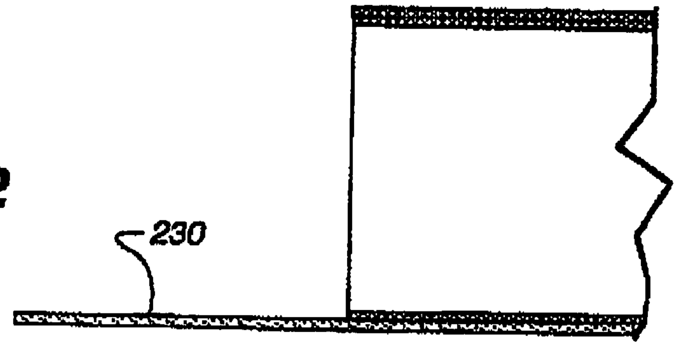
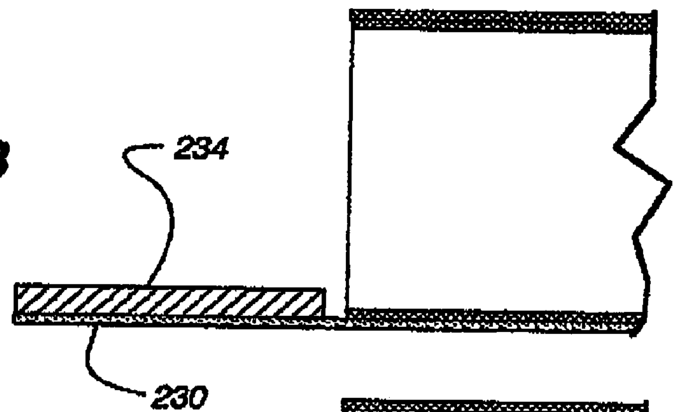


Fig. 93



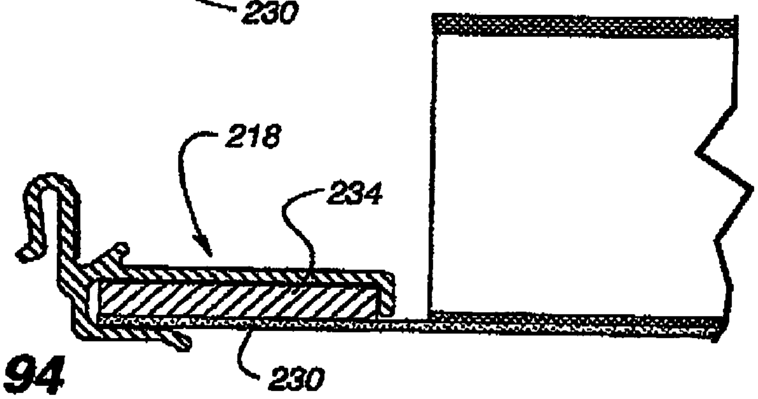
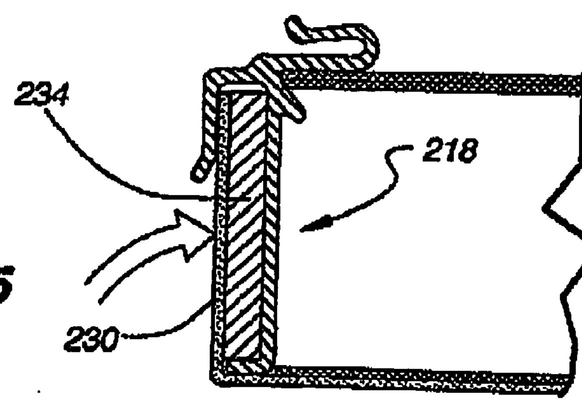


Fig. 94

Fig. 95



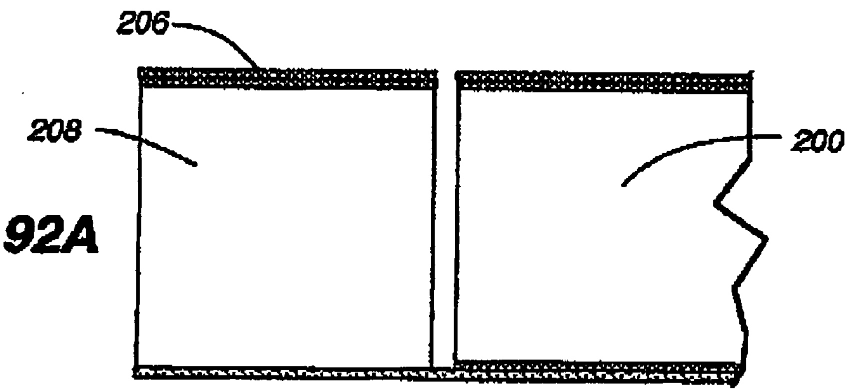


Fig. 92A

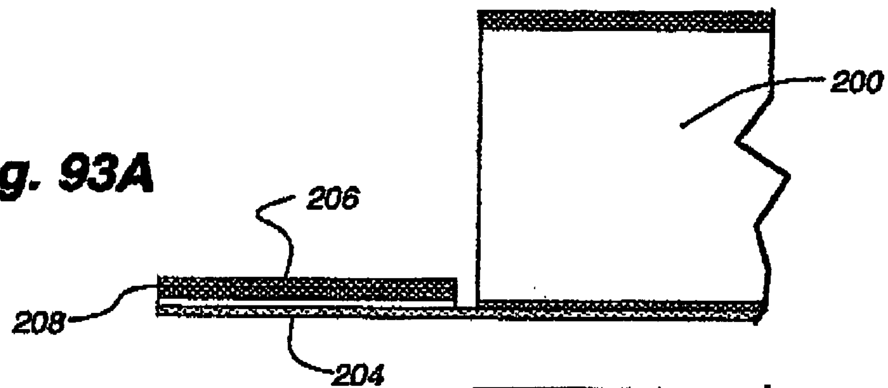


Fig. 93A

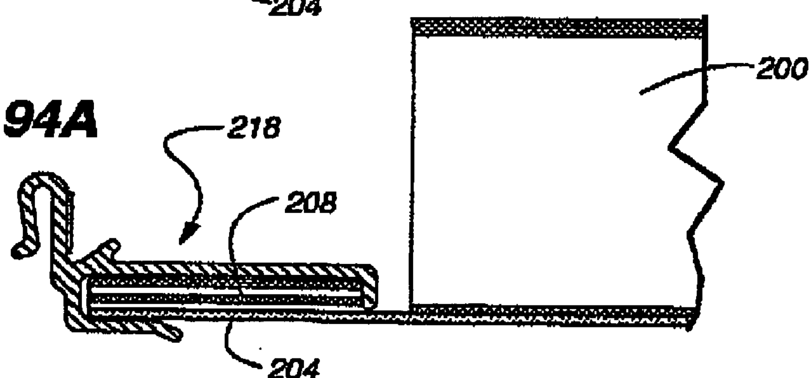


Fig. 94A

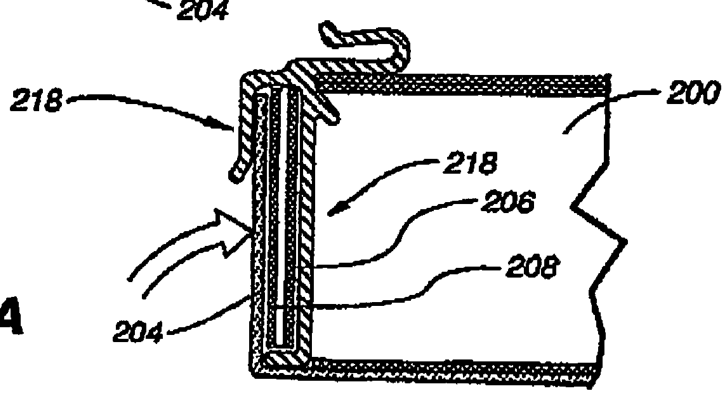


Fig. 95A

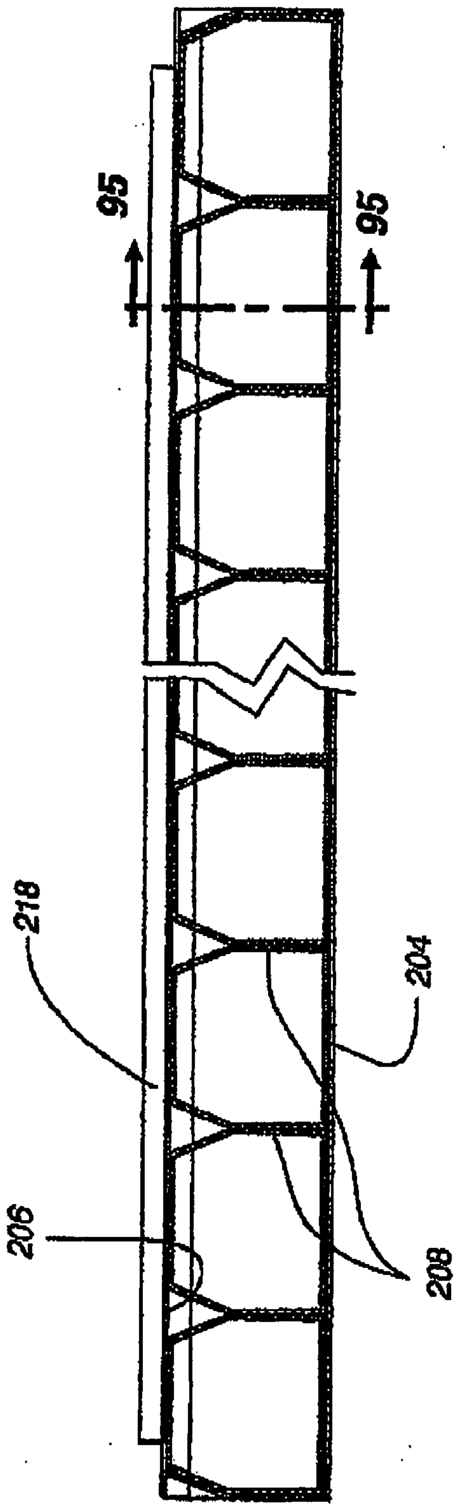


Fig. 96

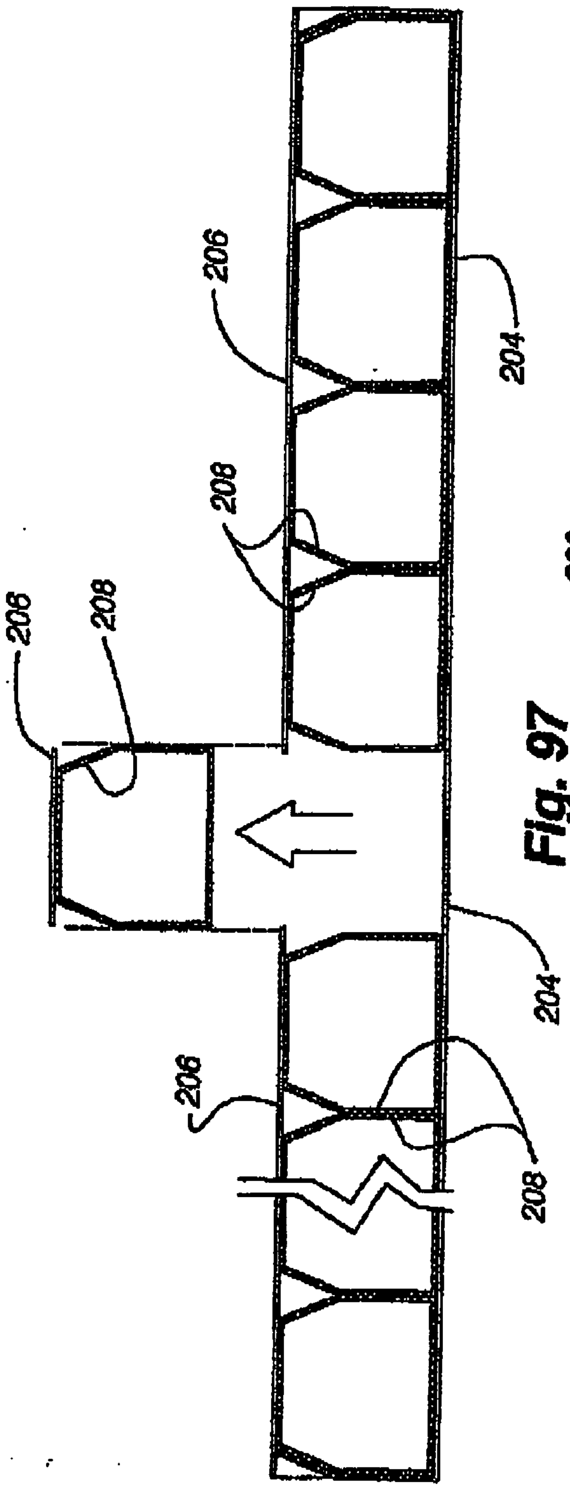


Fig. 97

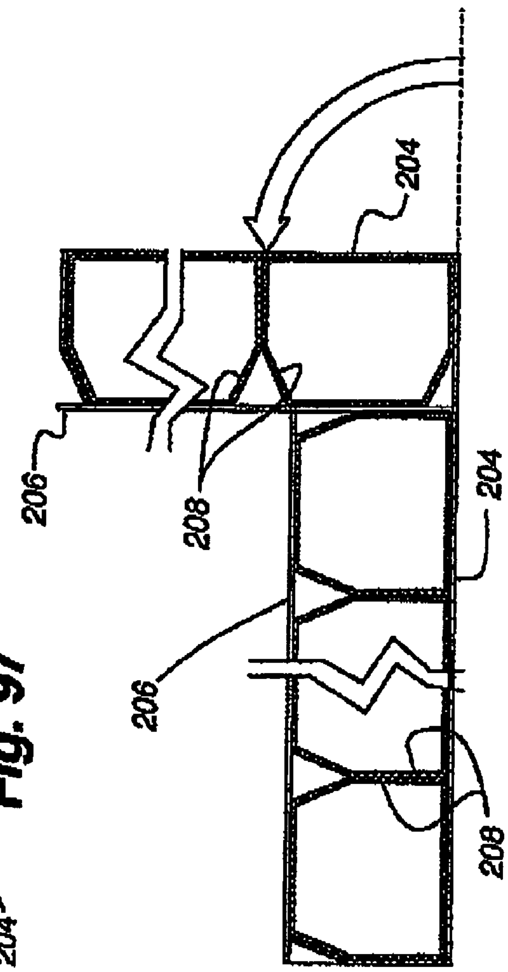


Fig. 98

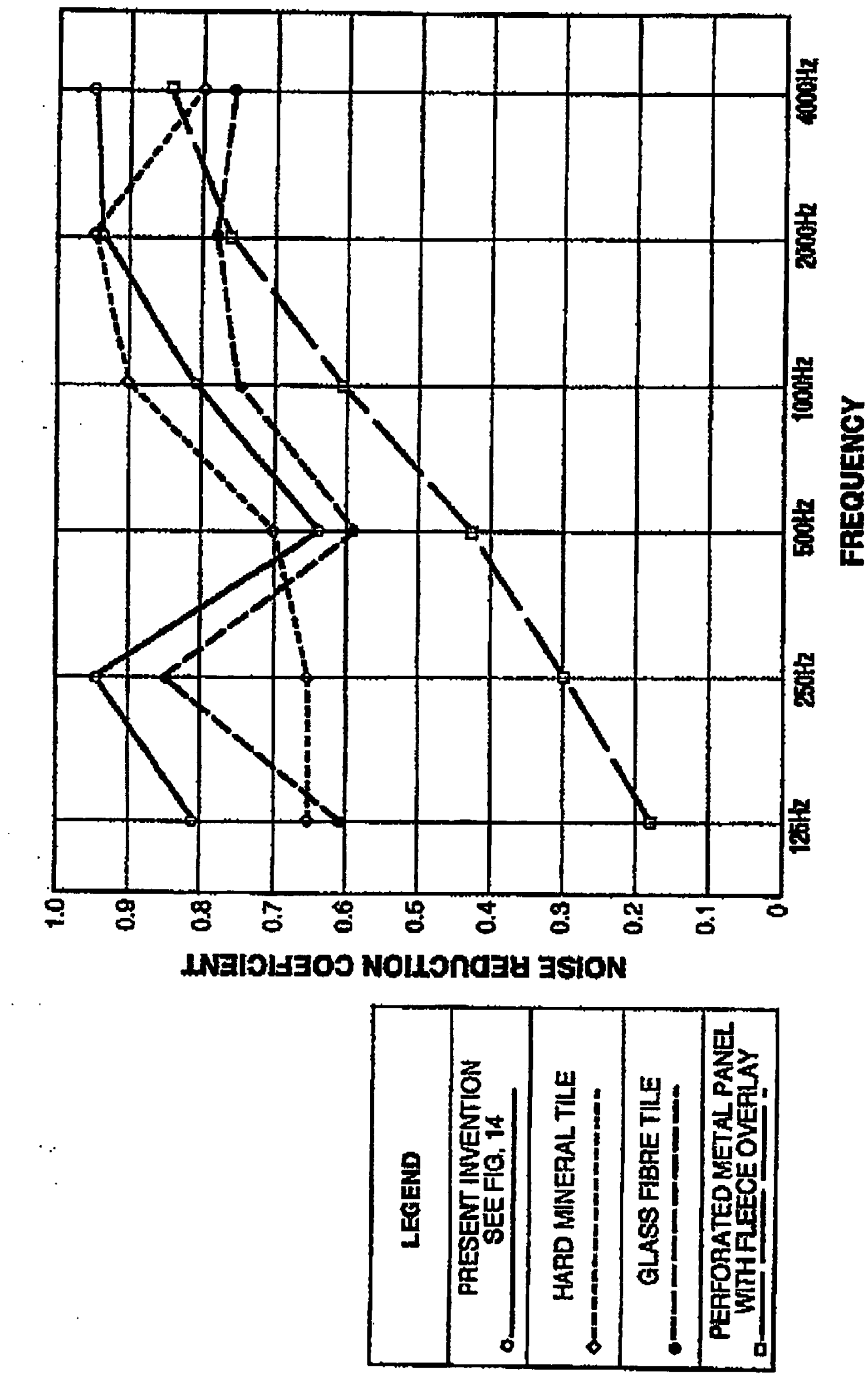

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
NOISE REDUCTION COEFFICIENT
125Hz
250Hz
500Hz
1000Hz
2000Hz
4000Hz
FREQUENCY
LEGEND
PRESENT INVENTION SEE FIG. 14
HARD MINERAL TILE
GLASS FIBRE TILE
PERFORATED METAL PANEL WITH FLEECE OVERLAY

Fig. 99

COMPRESSIBLE STRUCTURAL PANEL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application No. 60/199208, filed Apr. 24, 2000, which is hereby incorporated by reference as if fully disclosed herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] A structural panel which finds use as a ceiling panel or wall panel, includes an outer sheet having a plurality of spaced dividers protruding from one face thereof and a connecting sheet, or the like, parallel to and spaced from the outer sheet connecting the dividers together along their sides distal the outer sheet. The dividers are compressible for at least some period of time when pressure is applied thereto to reduce the thickness of the panel when desired, for example, for shipping purposes.

[0004] 2. Description of the Relevant Art

[0005] Structural panels used in the finish or decoration of building structures have taken numerous forms from drywall to decorative or acoustical ceiling panels. While such panels obviously have different characteristics, the panels have had numerous shortcomings, such as from a weight standpoint, a shipping standpoint, a lack of aesthetic or acoustical variety, and the like.

[0006] Some of these panels are used, for example, in drop ceiling systems wherein a gridwork of inverted T-shaped support members define rectangular openings in which acoustical panels or the like are placed. Such acoustical panels are typically rigid in nature and somewhat brittle. As a result, they are difficult to insert or remove from the supporting gridwork and in many cases are easily damaged during such process. Further, the ceiling panels are relatively heavy and are of a fixed thickness so that their shipping dimensions are the same as their installation dimensions. Due to their weight and bulk during shipping, the cost per square foot of such panels is relatively high.

[0007] Drywall is also relatively heavy, difficult to work with and has a shipping size identical to that of its installation size. The shipping cost for drywall is, therefore, also relatively high.

[0008] It will be appreciated from the above that structural panels used in the construction, finish and decoration of building structures suffer numerous shortcomings. A panel that would overcome such shortcomings would, therefore, be desirable.

SUMMARY OF THE INVENTION

[0009] The structural panel of the present invention can be used for a number of different uses as will be evident to those skilled in the art upon a reading of the present disclosure. Fundamentally, however, the panel would typically include an outer sheet of semi-rigid material with a plurality of dividers protruding from one face thereof. A connector in the form of a sheet or similar means is secured to the distal edges of the dividers. The connector could take the form of another sheet of material, strands of connective fibers, or the like.

[0010] The dividers are collapsible in nature and could take numerous forms. In some of the described embodiments, the dividers are elongated cells having collapsible sides so that when lateral or transverse pressure is applied to the cell in predetermined directions it will collapse into a shallow space. The dividers can be formed from folding a strip of semi-rigid material such that the longitudinal sides or partitions fold inwardly or outwardly when the divider is compressed laterally. The dividers are constructed so as to normally assume an expanded or extended position of predetermined configuration and are resilient so as to return to that configuration after having been compressed. The dividers are secured to the outer sheet and the connector so as to remain in position relative thereto.

[0011] As will be appreciated, with a panel so formed, it will assume an expanded form in its normal at rest condition, but by applying pressure to the outer sheet or the connector, the dividers are caused to collapse allowing the entire panel to assume a very thin thickness or profile. This, of course, is very advantageous for shipping purposes as a greater number of panels can be confined in a container than is possible with prior art panels that have a uniform thickness during shipping and use. The panels are also predominantly air filled and, therefore, are very lightweight.

[0012] It will further be appreciated from the more detailed description hereafter that the panels can be bent at least in one direction to facilitate installation in a drop ceiling or the like but are resilient to resume their normal at rest position. Further, the panels are not brittle and do not damage easily. They can, further, be cut very simply into any predetermined size and/or configuration.

[0013] Decorative sheets can also be overlaid onto the outer sheet, the connector sheet or the like of the panel to give the panel a desired aesthetic look. For example, a sheet of wood veneer, vinyl, patterned or contoured paper, colored paper, thin metal, polyester, other synthetic material, fabric, non-woven, or the like, can be overlaid so that the panel, when in use, has any desired appearance. Further, the panel can be interiorly or exteriorly lined with metal foil to change the properties of the panel.

[0014] Other aspects, features and details of the present invention can be more completely understood by reference to the following detailed description of a preferred embodiment, taken in conjunction with the drawings and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is an isometric view of a panel formed in accordance with the present invention.

[0016] FIG. 2 is a fragmentary isometric view looking upwardly at a drop ceiling in a building structure, with the panels of FIG. 1 incorporated therein.

[0017] FIG. 3 is an enlarged fragmentary section taken along line 3-3 of FIG. 2.

[0018] FIG. 4 is a front elevation of a strip of material from which a divider of the panel of the present invention is made.

[0019] FIG. 5 is a front elevation of the strip of material shown in FIG. 4 being creased to form pre-fold lines.

[0020] FIG. 6 is a front elevation of the strip of material shown in FIG. 4 after having been creased as shown in FIG. 5.

[0021] FIG. 7 is a front elevation of the strip of material shown in FIG. 6 having been folded along the preformed fold lines.

[0022] FIG. 8 is a front elevation of the divider as shown in FIG. 7 having been compressed.

[0023] FIG. 8A is an enlarged section of the circled area of FIG. 8.

[0024] FIG. 9 is a front elevation similar to FIG. 8 with a layer of adhesive shown in dashed lines positioned above and below the divider.

[0025] FIG. 10 is a front elevation similar to FIG. 9 with an outer sheet and a connector sheet being positioned above and below the layers of adhesive.

[0026] FIG. 11 is a front elevation showing the composite illustrated in FIG. 10 being heat compressed between heating elements.

[0027] FIG. 12 is a fragmentary end elevation of a panel formed in accordance with the present invention and with a decorative layer of material being adhesively secured to the outer sheet of the panel.

[0028] FIG. 13 is a fragmentary end elevation of the panel as shown in FIG. 12 being compressed between heated press elements.

[0029] FIG. 14 is an end elevation of a panel as shown in FIG. 12 having dividers with asymmetric partitions and with the panel fully expanded.

[0030] FIG. 15 is an end elevation similar to FIG. 14 with the panel being partially compressed.

[0031] FIG. 16 is an end elevation similar to FIG. 15 with the panel being slightly further compressed.

[0032] FIG. 17 is an end elevation similar to FIG. 16 with the panel being fully compressed.

[0033] FIG. 18 is an isometric view of the panel as shown in FIG. 14.

[0034] FIG. 19 is an enlarged isometric view of a portion of the panel shown in FIG. 18.

[0035] FIG. 20 is an isometric view of the panel shown in FIG. 18 in a fully compressed condition.

[0036] FIG. 21 is an enlarged isometric view of a portion of the panel as seen in FIG. 20.

[0037] FIG. 22 is an isometric view of a plurality of panels stacked together while in a compressed condition.

[0038] FIG. 23 is an isometric view of the panels shown in FIG. 22 in an expanded condition.

[0039] FIG. 24 is an enlarged fragmentary end elevation of the panel shown in FIG. 14 with end supports for the panel to inhibit the panel from bending.

[0040] FIG. 25 is a fragmentary section taken along line 25-25 of FIG. 24.

[0041] FIG. 26 is a fragmentary isometric with parts removed showing an end support on one end of the panel and a second end support being installed on the opposite end of the panel.

[0042] FIG. 27 is a fragmentary vertical section taken through a portion of the panel illustrating an alternative embodiment of the divider wherein the divider includes an inner layer of a metallic foil.

[0043] FIG. 28 is a fragmentary vertical section taken through the panel similar to FIG. 27 showing still another alternative arrangement of the divider wherein a metal foil is applied to the outer surface of the divider.

[0044] FIG. 29 is a transverse section taken through the panel as shown in FIG. 14 with the panel being compressed on its top surface.

[0045] FIG. 30 is a section taken along line 30-30 of FIG. 29.

[0046] FIG. 31 is an end elevation of the panel shown in FIG. 14 with the panel being curved concave upwardly.

[0047] FIG. 32 is an end elevation of a panel in accordance with a second embodiment of the present invention wherein the partitions of the dividers are symmetric rather than asymmetric as shown in FIG. 31.

[0048] FIG. 33 is an isometric view showing a panel in accordance with the present invention wherein the connection means are elongated strands or fibers that are secured to the dividers distally from the outer sheet.

[0049] FIG. 34 is an enlarged isometric showing a portion of the panel illustrated in FIG. 33.

[0050] FIG. 35 is an isometric view of the panel shown in FIG. 33 with the panel having been bent or curved so as to be upwardly concave.

[0051] FIG. 36 is an end elevation of a panel formed in accordance with the present invention and corresponding to the panel shown in FIG. 32.

[0052] FIG. 37 is an end elevation of the panel shown in FIG. 36 with the panel partially compressed.

[0053] FIG. 38 is an end elevation of the panel shown in FIG. 37 having been fully compressed.

[0054] FIG. 39 is an isometric view of the panel shown in FIG. 38 in a fully compressed condition.

[0055] FIG. 40 is an isometric view of a portion of the panel shown in FIG. 36 in a fully expanded condition.

[0056] FIG. 41 is an isometric view of a plurality of panels of the type shown in FIG. 36 having been compressed and stacked together.

[0057] FIG. 42 is an isometric view of a portion of the panels of the type shown in FIG. 36 having been stacked in a fully expanded condition.

[0058] FIG. 43 is a diagrammatic end elevation of a panel with asymmetric dividers illustrating dimensional characteristics thereof.

[0059] FIG. 44 is a diagrammatic end elevation of a panel with symmetric dividers illustrating dimensional characteristics thereof.

[0060] FIG. 45 is an enlarged end elevation of a portion of the panel of FIG. 43 illustrating other dimensional characteristics.

[0061] FIG. 46 is an enlarged end elevation of a portion of the panel of FIG. 44 illustrating other dimensional characteristics.

[0062] FIG. 47 is an end elevation similar to FIG. 45 showing the panel compressed with a force F.

[0063] FIG. 48 is an end elevation similar to FIG. 46 showing the panel compressed with a force F.

[0064] FIG. 49 is an isometric view of another embodiment of a divider for use in the panel of the present invention.

[0065] FIG. 50 is an end elevation of the divider shown in FIG. 49.

[0066] FIG. 51 is an end elevation of a panel including a plurality of the dividers shown in FIG. 49 in an expanded form.

[0067] FIG. 52 is a reduced end elevation of the panel shown in FIG. 51 in a compressed form.

[0068] FIG. 53 is an isometric view of still another embodiment of a divider for use in the panel of the present invention.

[0069] FIG. 54 is an end elevation of the divider shown in FIG. 53.

[0070] FIG. 55 is an end elevation of a panel formed in accordance with the present invention and utilizing the divider of FIG. 53 with the panel in an expanded form.

[0071] FIG. 56 is a reduced end elevation of the panel of FIG. 55 in a compressed form.

[0072] FIG. 57 is an isometric view of still another embodiment for a divider for use in the panel of the present invention.

[0073] FIG. 58 is an end elevation of the divider shown in FIG. 57.

[0074] FIG. 59 is an end elevation of a panel utilizing the divider of FIG. 57 with the panel shown in an expanded form.

[0075] FIG. 60 is a reduced end elevation of the panel shown in FIG. 59 in a compressed form.

[0076] FIG. 61 is an isometric view of still another divider for use in the panel of the present invention.

[0077] FIG. 62 is an end elevation of the divider shown in FIG. 61.

[0078] FIG. 63 is an end elevation of a panel utilizing the divider shown in FIG. 61 and with the panel in an expanded form.

[0079] FIG. 64 is a reduced end elevation of the panel shown in FIG. 63 in a compressed form.

[0080] FIG. 65 is an exploded isometric view of a panel similar to that shown in FIG. 1 that has been rigidified by providing additional dividers at the ends of the panel that extend perpendicular to the primary dividers.

[0081] FIG. 66 is a side elevation of the panel shown in FIG. 65.

[0082] FIG. 67 is an end elevation of the panel shown in FIG. 65.

[0083] FIG. 68 is an end elevation of a further embodiment of the present invention in which the panel can be bent at a right angle.

[0084] FIG. 69 is an isometric view of a panel formed as in FIG. 68 with the panel in a fully compressed condition.

[0085] FIG. 70 is a side elevation of the panel shown in FIG. 69.

[0086] FIG. 71 is an end elevation similar to FIG. 68 with the panel slightly further expanded.

[0087] FIG. 72 is an isometric view of the panel of FIG. 68 having been bent along a right angle and with the panel fully expanded.

[0088] FIG. 73 is an end elevation of the panel as shown in FIG. 72.

[0089] FIG. 74 is an fragmentary isometric view of an end of a panel with a segment of the panel having been partially cut.

[0090] FIG. 75 is a fragmentary isometric similar to FIG. 74 with the partially cut segment of the panel having been compressed and positioned for receipt of an elongated clip.

[0091] FIG. 76 is a fragmentary isometric similar to FIGS. 74 and 75 showing the clip having been mounted on the compressed segment of the panel.

[0092] FIG. 77 is a fragmentary isometric similar to FIG. 76 wherein the clip mounted on the compressed segment of the panel is being folded upwardly.

[0093] FIG. 78 is a fragmentary isometric similar to FIG. 77 wherein the clip mounted on the compressed segment of the panel has been folded 90 into abutment with the new end of the panel.

[0094] FIG. 79 is an enlarged fragmentary section taken along line 79-79 of FIG. 78.

[0095] FIG. 80 is a fragmentary isometric view of an alternative arrangement of a ceiling system wherein panels are suspended from rather than supported by a supporting gridwork.

[0096] FIG. 81 is an isometric view of a panel for use in the ceiling system shown in FIG. 80.

[0097] FIG. 82 is a fragmentary isometric view of an end of a clip member used in the panel of FIG. 81.

[0098] FIG. 83 is a fragmentary isometric view of the clip of FIG. 82 mounted on the longitudinal end of the panel shown in FIG. 81.

[0099] FIG. 84 is an enlarged fragmentary longitudinal section taken along line 84-84 of FIG. 80.

[0100] FIG. 85 is an enlarged fragmentary sectional taken along line 85-85 of FIG. 80.

[0101] FIG. 86 is a fragmentary vertical section similar to FIG. 85 with the conventional acoustical tiles removed from their supported relationship to the support members.

[0102] FIG. 87 is a fragmentary transverse vertical section taken through the panel of FIG. 81 showing the outer sheet extended from a longitudinal side edge of the panel.

[0103] FIG. 88 is a fragmentary vertical section similar to FIG. 87 with the extended outer sheet being folded up and adhesively secured to a longitudinal end of the panel of FIG. 81.

[0104] FIG. 89 is a fragmentary vertical section similar to FIG. 88 with the panel slightly compressed.

[0105] FIG. 90 is a fragmentary vertical section similar to FIG. 89 with the panel further compressed.

[0106] FIG. 91 is a fragmentary vertical section similar to FIG. 90 with the panel substantially fully compressed.

[0107] FIG. 92 is a fragmentary longitudinal vertical section showing the outer sheet extending longitudinally from one end of the panel of FIG. 81.

[0108] FIG. 93 is a longitudinal fragmentary vertical section similar to FIG. 92 with a stiffener strip supported on the outer sheet extension.

[0109] FIG. 94 is a longitudinal fragmentary vertical section similar to FIG. 93 with a clip secured to the outer sheet extension.

[0110] FIG. 95 is a longitudinal fragmentary vertical section similar to FIG. 94 with the clip being folded upwardly to overlie the longitudinal end of the panel.

[0111] FIGS. 92A-95A are views identical to FIGS. 92-95, respectively, showing an alternative system for mounting a clip to the end of a panel with the end of the panel being compressed in a manner to replace the stiffener strip used in FIGS. 92-95.

[0112] FIG. 96 is an enlarged fragmentary transverse vertical section taken along line 96-96 of FIG. 81.

[0113] FIG. 97 is a transverse section with portions removed showing one divider being removed to facilitate a folding of the panel.

[0114] FIG. 98 is a transverse section with portions removed similar to FIG. 97 showing the panel folded about the space where the divider was removed as seen in FIG. 97.

[0115] FIG. 99 is a graph illustrating acoustical comparisons between a panel in accordance with the present invention and other panels.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0116] The compressible structural panel 50 of the present invention is probably best shown in FIGS. 1 and 12 to include a plurality of collapsible preferably parallel dividers or beams 52 extending between an outer sheet 54 (not seen in FIG. 1) and a connector sheet 56. A decorative sheet 58, as seen in FIGS. 1 and 12, may be provided to overlie in face-to-face relationship the outer sheet 54. As will be explained in more detail later, the panel is compressible from its normal expanded condition shown in FIGS. 1 and 12 to a fully collapsed or compressed condition as shown in FIG. 17. The panel is also bendable in one transverse direction, as will be described in more detail later, but can be rigidified to inhibit bending in any direction. The panel is further comprised mostly of air and is, therefore, very light and easy to handle.

[0117] The panel 50 has many possible uses in building structures, such as, for example, it might be used as a wall panel, fixed ceiling panel, as panels for a drop ceiling, or the like. It will also be appreciated from the description that follows that the panels could be made of different sizes some of which might be inordinately large in comparison to conventional panels used in building structures. For purposes of the present disclosure, the panel is illustrated of conventional size and for use in a drop ceiling as shown in FIG. 2.

[0118] In a typical drop ceiling system, a gridwork of elongated inverted T-shaped support members 60, as seen in FIGS. 2 and 3, are conventionally supported from a ceiling thereby defining rectangular openings 62 and peripheral support edges 64 around those openings on which a ceiling tile or panel 50 can be positioned. Traditional ceiling panels, not being bendable or otherwise pliable, are difficult to insert into the rectangular openings 62 and due to the fact that they are also brittle, they are many times damaged or broken when being inserted. The panel of the present invention, as will be appreciated with the description that follows, is inherently bendable so as to facilitate its insertion into the rectangular opening of a drop ceiling system and once in place will resume a desired flat planar orientation.

[0119] As probably best seen in FIG. 12, the dividers 52 are formed from individual strips 66 (FIG. 4) of material which have been pre-creased and folded into a desired configuration so that when incorporated into the panel 50 are transversely collapsible allowing the panel to be compressed if desired. The dividers are secured along top portions thereof to the connector sheet 56 and along bottom portions thereof to the outer sheet 54 with the connections desirably being made with adhesive 68, but other systems for connecting the components would be evident to those skilled in the art. The outer sheet is, in turn, adhesively or otherwise secured in face-to-face relationship to the decorative sheet 58, which is the sheet that is exposed to the interior of the building structure in which the panel is incorporated. A sheet may be defined as one or more pieces of material interlocked, bonded, welded, or otherwise joined to define a broad expansive surface. The decorative sheet could be any material such as real or synthetic wood, vinyl, patterned or contoured paper, foil, polyester, other synthetic material, fabric, non-woven, or the like. Of course, this material would normally be selected for the desired decor of the room in which the ceiling panel is being incorporated but might also be selected for its acoustical properties.

[0120] In the disclosed embodiment, the outer sheet 54, the connector sheet 56 and the dividers 52 may be, but would not necessarily be, made from the same material. That material might be a fiberglass sheet composed of randomly oriented glass fibers bonded together in a resin. As will be explained in more detail later, the resin could be a thermosetting resin or a thermoplastic resin depending upon the desired characteristics of the panel. The adhesive 68 used to join the various components of the panel might typically be a thermosetting adhesive, which bonds the adjacent components upon attaining a predetermined temperature. Illustrations of suitable adhesives would include, however, poly-

urethane resins, copolyester hot melts, hot melt polyurethane reactive adhesives, two part epoxies, two part urethanes and RTV silicones.

[0121] The dividers 52, as best illustrated in cross-section in FIG. 12, might, in combination, be formed from one continuous strip of material but in the disclosed embodiment are each individual dividers of an elongated cellular or tubular configuration. Each divider is formed from the strip 66 of material such as fiberglass in a manner as shown in FIGS. 4-11.

[0122] In FIG. 4, a front view of the flat strip 66 is illustrated before it is passed into a creaser. In the creaser, as seen in FIG. 5, the material is passed between rotary creasing wheels 70 and back up rollers 72 so that longitudinally extending creases 74 are formed in the material at predetermined laterally spaced locations. In the preferred system, the creasing wheels have an arcuate creasing edge approximately a 1/32" diameter and the back-up rollers are of 90-durometer hardness. With this apparatus, an efficient fold line is created without cutting the material or at least without damaging many, if any, of the glass fibers so that a spring force is retained in the material. As will be appreciated, starting at the left of the strip of material as shown in FIG. 5, a crease 74*a* is placed near the left edge in the top surface and another crease 74*b* is placed in the top surface at a location spaced slightly to the left of center. Between these two locations a crease 74*c* is placed in the bottom surface of the strip. Corresponding creases are placed on the right side of the strip so that the strip upon exiting the creaser has six creases formed therein as illustrated in FIG. 6. The strip 66 of material is then folded over and along the longitudinal creases as illustrated in FIG. 7, 8 and 8A bringing the side edges 76 of the strip together at a centered location on the top of the divider 52. Preferably, the breaking diameter of the fibers in the material is less than the combined thickness of the folded material so that minimal, if any, damage occurs to the fibers during folding. When so formed, the divider forms an elongated tube or cell comprised of two truncated triangles 78 and 80 that are inverted relative to each other. The lower triangle 78 has a broader base than the upper triangle 80. The fiberglass material from which the divider is made is semi-rigid so that it can be flexed and folded along crease lines 74 but remains substantially flat between such folds. Applying pressure to the cell as configured in FIG. 7 in a vertical direction causes the components of the cell to collapse so that the divider assumes a compressed configuration as shown in FIG. 8. In the compressed configuration, the adhesive 68 can be applied across the top and bottom of the divider with the adhesive preferably being a thermosetting or thermoplastic adhesive applied in any of various different ways, which would be readily known to those skilled in the art.

[0123] As seen in FIG. 10, the divider 52 with adhesive 68 applied to its upper and lower faces is then passed between the outer sheet 54 and the connector sheet 56 and as seen in FIG. 11, the entire laminate is then compressed between heated plates 82 which activate the adhesive 68 in the case of thermoplastic adhesives or act as a catalyst in the case of thermosetting adhesives. Subsequent heat may be used to increase the curing rate of a thermosetting adhesive if selected.

[0124] If a thermosetting resin is used in bonding the glass fibers within the strips 66 and sheets 54 and 56 of material, the panel 50 will naturally expand to its preformed condition, as shown in FIG. 12, after having been compressed and bonded together. If the resin bonding the glass fibers is a thermoplastic resin, it will remain compressed but need only be reheated and the strips will inherently expand under the heat, which might be applied, for example, with a hair dryer. Under any circumstance, the panel can either inherently expand or be selectively expanded to a desired height or thickness.

[0125] While it would be evident to one skilled in the art to modify the material from which the dividers 52, outer sheet 54 and connector sheet 56 are made, and in fact they could each be made of different materials, for purposes of the present disclosure, the following materials have been found satisfactory for each of the outer and connector sheets as well as the dividers:

[0126] JM type 8802-100GSM (Glass Mat with thermoplastic resin) or JM type MF5020GSM (Glass Matt with thermosetting resin), each made by Johns-Manville Corp. of Denver, Colorado; or Ahlstrom type 5150 GSM (Glass Tissue with thermosetting resin) made by Ahlstrom of Karhula, Finland.

[0127] There are other materials that might work well, for example, for the outer sheet or the connector sheet but not for the dividers and, conversely, there are some materials that might work well for the dividers but not for the outer and connector sheets. For example, the outer and connector sheets could be one of many different sheet types of material, such as paper, cardboard, metal, plastic, polyester, other synthetic material, or the like. It does not even need to have structural stability as such stability is given to the panel by the dividers. The dividers, on the other hand, while preferably being made of fiberglass, could be made of a carbon fiber mat, some papers, cardboards, woven materials, films, or combinations thereof, with the important feature being that they have some predetermined modulus of resiliency, similar to the specific materials identified above, which allows them to be folded but remain resilient. If the materials are to be creased to define fold lines as discussed above in connection with fiberglass material, it is important that the material retain the modulus of resiliency after having been creased, which, of course, is true with fiberglass or carbon fiber materials.

[0128] As seen in FIG. 13, the decorative sheet 58 could also be positioned between the outer sheet 54 and the heat press 82 with a suitable adhesive 66 therebetween to bond the decorative sheet in face-to-face relationship to the outer sheet. The resulting panel, of course, is illustrated in FIG. 12. When bonding the decorative sheet to the outer sheet and in addition to the alternatives mentioned above, a porous decorative sheet can be used which is bonded to the cover sheet with adhesive in a grid or printed dot pattern. This would allow the lamination to more freely pass or transmit sound therethrough. Conversely, if a continuous layer of adhesive were used to join the decorative sheet and the cover sheet, the transmission of sound through the laminate would be decreased. Through the lamination process, a relatively unstable decorative sheet can be rendered flat and stable with the resultant flat surface possibly also providing impact and puncture resistance superceding that of the cover sheet. It will be appreciated that the acoustics of the panel can be changed by varying the outer sheet material, the strip

material, the adhesive, the connector sheet, the spacing between the sheets, the manner in which the assembly is joined together, or the like.

[0129] Other materials could cover or be laminated to the connector sheet 56 as well. For example, films could be applied over the connector sheet or an additional sheet of non-fiberglass material laminated thereto. The panel in such case could be handled without gloves in that fiberglass can be abrasive and otherwise harmful to exposed skin. Further, the film or laminate for the connector sheet 56 could be printed with a manufacturer's identification or with a measuring grid to facilitate cutting the panel to desired sizes. Further, and as mentioned previously with regard to the outer sheet 54, porous laminates or films could also be overlaid onto the connector sheet for acoustical purposes.

[0130] As mentioned, numerous materials might have applicability in the present invention, but in the preferred mode, the connector sheet and the dividers are made of the same material, which is a fiberglass mat made by Johns-Manville Corporation and the mat may be one designated No. 5802 or one designated No. 5803 by Johns-Manville. The 5802 is a 120 g/m^2 mat composed of 10% PET/65% 16-micron glass/25% MF. The 5803 is a 100 g/m mat composed of 12% PET/68% 16-micron glass/20% MF. MF is an abbreviation for melamine formaldehyde resin, which exhibits the characteristics of a thermoset resin. PET is an abbreviation for a polyethylene terephthalate. Dividers made from either of the 5802 or 5803 material have the ability to expand with little or no addition of heat after having been creased and folded as described previously and after having been fully compressed. A more complete description of the Johns-Manville products and related products can be found in U.S. Pat. Nos. 5,840,413, 5,942,288, and 5,972,434, which are herein incorporated by reference.

[0131] The preferred outer sheet is a composite lamination of an aesthetically pleasing textile material, which has been laminated to a glass non-woven base using a co-polyester hot-melt adhesive. Three different laminates are equally desirable. The first laminate utilizes a base substrate in the nature of a thermal bond polyester non-woven having a basis weight in the range of 45 to 75 g/m^2 and can be purchased from Hollingsworth and Vose of Floyd, W.Va. The adhesive pattern used to thermally bond the polyester fibers in the non-woven base substrate becomes the visual pattern upon the bottom surface of the outer sheet. When a small point-bonding pattern with a bonding area of approximately 7% is used, the preferred polyester non-woven material is one designated by Hollingsworth and Vose as TR2315A-B. When a large point-bonding pattern is used, approximately 21% bonding area, the preferred material is designated TR2864C1 by Hollingsworth and Vose. Either non-woven base substrate is then screen coated using an acrylic binder/flame retardant coating with an additional weight of 15 to 25 g/m^2. The coating can be formulated to increase the durability of the non-woven base substrate while adding flame retardant. The polyester non-woven base substrate can then be run through a hot-melt roll coater/laminator where a flame resistant co-polyester adhesive from, for example, EMS Chemie North America of Sumter, N.C., is applied to the surface of either the polyester non-woven base substrate or the material to be coated thereon. The coating weight of this adhesive is dependent upon the bond strength desired to achieve between the polyester non-woven base substrate and the glass non-woven materials. Generally an adhesive having a basis weight in the range of 30 to 45 g/m^2 has been found desirable. A Gravure roller, preferably having a cross-hatch 25×25 pattern thereon is used to compressively laminate the glass non-woven to the polyester non-woven base substrate. The depth of the engraving on the Gravure roller is a main variable related to the adhesive weight per area being applied. The adhesive formulation obtained from EMS Chemie is a 50:50 mix of two materials with the materials designated by EMS as Grilltex D1573G and Grilltex VP1692G. The EMS Grilltex VP1692G is compounded with a 25% loading of an organic phosphorous flame retardant. The resulting 50:50 mix produces a final flame-retardant loading of approximately 13.5%. Following the application of the adhesive upon the surface of the polyester non-woven, the adhesive is kept molten until it reaches the nip of the roll coater/laminator where it is joined with the glass non-woven. The glass non-woven is preferably the afore-noted 5802 (120 g/m^2) matting sold by Johns-Manville, a glass non-woven from Ahlstrom designated GFT-413G10-60-1300 (60 g/m^2) or a non-woven glass matting from Ahlstrom designated GFT-413G10-80-1300 (80 g/m^2). A composite laminate made with the above-noted materials is inherently translucent and that feature combined with the ability of light to travel down the length of the cells defined between the dividers in a finished panel makes it possible to see shadows in the areas where two cells meet.

[0132] The shadowing can be decreased if desired, by using, in lieu of the afore-noted polyester non-woven, an aesthetic material having a silver, gray, or black color upon its back side. The backside is the one, which receives the hot-melt adhesive and is subsequently laminated to the glass non-woven matting. The coloring reduces the amount of light which can travel down the cells and up through the surface thus reducing the shadowing effect.

[0133] An alternative aesthetic material to the polyester non-woven described above is a knit material, which has a silver, gray, or black appearance on one side. To achieve this, a knit material from Gilford technical textiles of Greensboro, North Carolina, has been used with the knit material being composed of two different types of yarns in a single knit construction. The preferred yarns used are nylon and polyester. The nylon yarns are mainly observed on one side of the matting and the polyester on the other. The knitted material is "cross-dyed" with black dyestuffs that have affinity for the nylon and leaving the polyester white in color. A flame retardant and soil release may also be added to the dye bath formulation. The knit is then stabilized and a melamine resin added to stiffen the fabric. The knit material can then be run through the roll coater/laminator to laminate the knit material to the glass non-woven material as previously described with the polyester fiber material. The preferred Gravure roller pattern used in this case is one having a random computerized dot pattern and which is well known in the trade. When the silver, gray, or black side of the knit is laminated to the glass non-woven material, the light transmittance through the laminate is reduced by the presence of the darker layer. The visual appearance of the surface is unique in that it mimics the appearance of a perforated metal ceiling panel. You can also laminate the white side of the knit material to the glass non-woven material and when doing so, the appearance of the knit lamination mimics a metal screen material but also eliminates the shadowing effect.

[0134] Another method of reducing reflected light and transmitted light shadowing is the use of a colored black, gray, or silver glass non-woven material. If the pigmented black, gray, or silver glass non-woven is laminated to either the polyester fiber mat or the knit matting described previously, the shadowing effect can also be reduced.

[0135] It should also be noted that the coloring of the aesthetic material, whether it be the polyester fiber matting or the knit material, could be obtained by printing or coating the materials with a colored pigment. This would involve a secondary printing or coating step, which would add to the cost. The use of colored or pigmented adhesive may also be employed as a low-cost solution to the shadowing and/or increased surface whiteness of the aesthetic material.

[0136] FIGS. 14-17 illustrate the assembled panel 50 in progressively compressed conditions with FIG. 14 showing the panel in a fully expanded condition and FIG. 17 in a fully collapsed or compressed condition.

[0137] An isometric view of the panel 50 is shown in FIG. 18 and an enlargement thereof in FIG. 19. It will there be readily appreciated that the dividers 52 are evenly spaced from each other while extending parallel to each other and longitudinally of the panel. Of course, in FIGS. 18 and 19, the panel is fully expanded with the panel being shown fully compressed in corresponding views 20 and 21, respectively.

[0138] A problem with conventional ceiling panels is that they remain of the same size and thickness during shipment, installation and use. A desirable feature of the panel of the present invention resides in the fact that, while the panel has a predetermined at rest thickness that might correspond with that of conventional ceiling panels when fully expanded, it can be compressed for shipping purposes so that far more panels can be packed in one container for shipping purposes thereby improving shipping costs considerably. When the panels are removed from the shipping container, they will either naturally expand if a thermosetting resin was used in the fiberglass material or can be heated to expand if a thermoplastic resin was used. While the panel could be expanded to any desired thickness, a preferred panel for ceilings might be in the range of 12 to 26 mm in thickness when desirably expanded depending on the span of the panel but could be thicker or thinner depending on use, and approximately 3-4 mm in thickness when fully compressed.

[0139] As best seen in FIG. 31, the panel 50 can easily be flexed or bent transversely of the direction in which the elongated dividers 52 extend to facilitate the insertion of the panel into the support structure of a drop ceiling, for example. In fact, the panel can be preformed in the bent configuration so that this becomes its at rest configuration should a curved panel be desired for some reason. The panel will not flex or bend very easily in the opposite direction, i.e. the direction in which the dividers extend, as the tubular configurations of the dividers will inhibit such. If desired, however, the panel can be substantially rigidified so that it is inhibited from bending in either transverse direction by placing support members 84 along opposite ends of the panel so as to cover the open ends 86 of the tubular or cellular dividers. The support members 84 can either be preformed C-shaped channel members 88 (such as plastic, aluminum, etc.) of a rigid configuration, as illustrated in FIGS. 24 and 25, or can be strips 90 of adhesive material, for example, which are adhered to the ends of the panel as illustrated in FIG. 26. While the strips of adhesive material would have some flexibility, it would have enough stiffness so that when incorporated onto the ends of the panel, it will inherently prevent the panel from bending in a transverse direction relative to the longitudinal direction of the dividers. Plastic or vinyl tapes or the like would be an illustration of a suitable adhesive strip. As a further alternative and as shown in FIGS. 65-67, a divider 52*a* could be placed at each end of the panel to cover the open ends of the parallel dividers 52. The outer sheet 54 and connector sheet 56 are extended to cover the dividers 52*a* which serve to rigidify the panel in the cross direction.

[0140] The panel can also be rigidified in a cross-direction by incorporating cross dividers (not shown) at selected locations throughout the panel. The cross dividers would run perpendicular to the primary dividers and might assume an identical or varied configuration to the cross-sectional configuration of the primary dividers. Of course, the cross dividers could be adhesively bonded in the panel the same as the primary dividers. The height of the dividers, whether they be primary dividers or cross dividers, can also be varied across the width of a panel to create varied structural and aesthetic effects.

[0141] To change the structural characteristics of the dividers 52, the outer or inner surface of the divider can also be laminated with another sheet of material and possibly a metallic sheet material 92, which renders the divider material slightly more rigid, as illustrated in FIGS. 28 and 27, respectively. A metallic sheet would also affect the thermal characteristics of the panel. FIG. 27 shows the metallic sheet material on a panel with a support member 88 while FIG. 28 does not include a support member. Of course, the lamination process would take place during the formation of the divider and preferably immediately before creasing.

[0142] As seen in FIGS. 29 and 30, the panel formed in accordance with the above process is unique in that pressure applied at any one location to one surface of the panel will only depress the panel at that location and will not deform the opposite side of the panel. The panel will also support multiples of its own weight without deflection on the opposite side of the panel. By way of example, a panel formed in accordance with the present invention that is 26 millimeters thick when expanded and which is 24 inches wide by 48 inches long weighs approximately 0.9 kilograms (1.98 pounds). The panel can support up to 2.9 kilograms load (6.38 pounds) in the form of a circular weight 10 inches in diameter with minimal deflection observed on the opposite side of the panel. Point loads of approximately 2 inches in diameter and weighing 1 kilogram (2.2 pounds) are also easily absorbed by the same panel with no deflection of the bottom surface.

[0143] With reference to FIGS. 33-35, a second embodiment of a panel 94 is illustrated wherein the connector sheet 54 has been replaced with a connector in the form of a plurality of elongated flexible but non-extensible strands or fibers 96. These strands or fibers could be plastic, nylon or other similar material having the same or similar characteristics. The strands or fibers of material can be adhesively or otherwise bonded to tubular dividers 52' while extending transversely thereto and with the fibers spaced from each other preferably in a parallel relationship to each other. A panel 94 so formed can be easily flexed or bent, as illustrated

in FIG. 35, in a direction transverse to the longitudinal direction of the dividers as with the previously described panel.

[0144] In each of the afore-described embodiments of the invention, the dividers have identical side partitions 98 (FIGS. 12 and 34) which have longitudinal fold lines 100 therein so that the side partitions collapse inwardly when the panel is compressed. The side partitions thereby define upper and lower portions *98a* and *98b*, respectively, which are rectangular in configuration but wherein the upper portion *98a* is of a smaller dimension than the lower portion *98b*. This arrangement might be referred to as an asymmetric arrangement in that the upper portion of the divider is of a different size than the lower portion.

[0145] A third embodiment of the present invention is illustrated in FIGS. 36-42 and in this embodiment, a panel 102 is identical to that shown in FIG. 12 except that the partitions 104 in the dividers 105 are symmetric in configuration. In other words, the panel 102 includes an outer sheet 54' and a connector sheet 56' interconnected by dividers with partitions and may include a decorative panel 58' overlying the outer sheet if desired. Fold lines 106 along the partitions 104, however, are positioned so that an upper rectangular portion *104a* of each partition is of equal size to a lower rectangular portion *104b*. The panel 102 can again be compressed.

[0146] The compressed and expanded forms of the panel 102 shown in FIGS. 36-38 are illustrated isometrically in FIGS. 39 and 40 and it will be appreciated that the panel can be fully compressed to a depth or profile that is far less than its normal expanded condition.

[0147] As seen in FIGS. 41 and 42, when the panels are stacked, a considerable amount of space can be saved by compressing the panels, which, of course, saves considerable expense when shipping as, more panels can be compressed and shipped in one container than with conventional ceiling panels.

[0148] An advantage of a panel using symmetric dividers resides in the elimination of telegraphing that can, if not carefully watched, exist in compressed panels. Telegraphing is a phenomenon that can result in compressed panels of the type described herein when a sheet is compressed tightly against other components of the panel such as dividers or partitions. If the pressure is too great or the dividers exert too much resistance, a visual pattern can be seen through the sheet where a partition is secured thereto and where it is not.

[0149] By reference to FIG. 17, which illustrates a panel with asymmetric dividers, it will be appreciated there are spaces between the dividers along their connections to the connector sheet, but such a gap hardly exists when using symmetric dividers as best seen in FIG. 38. Accordingly, in a panel using symmetric dividers as shown in FIG. 38, telegraphing is virtually eliminated regardless of the pressure applied to the panel. It should also be appreciated, however, that in panels of the present invention with symmetric or asymmetric dividers, there is less tendency for telegraphing due to the fact that when the connector sheet is forced downwardly against the dividers, they do not resist the pressure but simply compress so that an adequate pressure for bonding the connector sheet to the dividers can be applied without creating telegraphing.

[0150] By changing the location of the fold line 106 in each side partition of a divider 105, the resistance of the panel to compression can also be regulated. For example, in the at rest expanded position of an asymmetric panel 50 such as disclosed as the first embodiment of the present invention and shown in FIGS. 43 and 45, an obtuse angle (a) is formed in the side partition 98 which is greater than the corresponding angle (d) in the partition 104 as shown in FIG. 46 of a symmetric panel. The height A of each panel in the expanded form is, however, identical. Note also the difference in the length B and C of the upper and lower portions *98a* and *98b*, respectively, of the side partitions of the asymmetric divider, whereas in the symmetric divider illustrated in FIG. 46, the length D of the upper partition portion *104a* and the lower partition portion *104b* are identical.

[0151] The greater the angle (a) or (d) in the side partition, the more resistance there will be to compressing the panel, as illustrated in FIGS. 47 and 48. In FIGS. 47 and 48, an equal force F is shown being applied to the asymmetric divider panel 50 in FIG. 47 and the symmetric divider panel 102 in FIG. 48 and it will be seen that the same amount of force compresses the symmetric divider panel a greater amount. This is because the angle in the side partition in the symmetric divider panel is smaller than the angle in the asymmetric divider panel.

[0152] By way of illustration and not limitation, in a panel formed in accordance with the present invention which has been found to provide satisfactory performance and wherein the outer sheet, connector sheet and dividers are all made of 100GSM Johns Manville #8802 glass matting, the parameters identified in FIGS. 43 through 46 fall in the following ranges:

[0153] X=5 to 10 mm

[0154] S=20 to 40 mm

[0155] A=15 to 26 mm

[0156] B=8 to 10 mm

[0157] C=13.5 to 17 mm

[0158] D=13.5 to 15 mm

[0159] a=100 to 120 degrees

[0160] b=100 to 120 degrees

[0161] In another alternative embodiment 108 of a panel in accordance with the present invention shown in FIGS. 51 and 52, the connector sheet of the previously described embodiments is eliminated by the use of a unique divider 110. The divider 110, as best seen in FIGS. 49 and 50, is of generally hourglass configuration defining two truncated triangular zones 112 and 114 inverted relative to each other similarly to the first described embodiment of the present invention, but the top of the divider has a long horizontal leg adapted to overlap an adjacent divider so as to have a segmented connector sheet 116 that is composed of a plurality of interconnected strips defined by the horizontal top leg of the divider. While the divider 110 has been shown to be asymmetric, it could, in fact, assume a symmetric configuration similar to that shown in the third described embodiment of the present invention. The divider, therefore, has a base 118, a left side partition 120 and a right side partition 122, with each side partition having a horizontal leg

124 and 126 respectively at its top. Both of the side partitions have a crease line 128 so that the side partitions will collapse when pressure is applied to the top or bottom of the divider. The horizontal top leg 126 of the right side partition is approximately a third of the width of the divider at its top, but the horizontal leg 124 from the left side divider is slightly longer than the base 118 of the divider so that it overlies and overlaps the horizontal top leg 122 of the right divider.

[0162] As is best seen in FIG. 51, when a plurality of the dividers 110 are positioned in immediately adjacent or contiguous side-by-side relationship, the top horizontal leg 124 from the left side partition 120 extends beyond the right side partition 122 and into overlapping relationship with the top horizontal leg 124 of the left side partition 120 of the next adjacent partition to the right. The overlapping horizontal top legs 124 from the left side partitions thereby form in combination a segmented but integrated connector sheet. Of course, the top horizontal leg 124 from the left side partitions of each divider is adhesively secured to the top horizontal leg 126 from the right side partition and also to the top horizontal leg 124 from the left side partition of the divider that is to the immediate right thereof. A cover sheet 130 is secured to the base 118 of each of the dividers to interconnect the dividers along their bases and, of course, a decorative sheet (not shown) can be secured to the lower face of the outer sheet or the segmented connector sheet if desired.

[0163] Still another embodiment 132 of a panel formed in accordance with the present invention is shown in FIGS. 53-55, and in this embodiment, the dividers 134 are not cellular in and of themselves but are rather strips of material that have been folded into a zig-zag pattern and secured between an outer sheet 136 and a connector sheet 138 so as to form a cellular compressible panel. Looking initially at FIGS. 53 and 54, the divider 134 is formed from a strip of material which has a pair of outer parallel crease lines 140 and inner parallel crease lines 142 but with the outer crease lines being folded in opposite directions and the inner crease lines being folded in opposite directions. A pair of attachment surfaces or marginal zones 144 and 146 are thereby defined between the outer crease lines 140 and the side edges 148 of the strip which can be secured in any suitable manner to the outer sheet and the connector sheet respectively. In between these marginal zones of the dividers, an intermediate portion 150 of the divider has the two inner folds therein allowing the strip to collapse when transverse pressure is applied to either of the marginal zones. The panel 132 formed with the dividers 134 of FIGS. 53 and 54 is shown in FIGS. 55 and 56 in an expanded and compressed condition, respectively.

[0164] Another divider 152 is shown in FIGS. 57 and 58 for use in a panel 154 shown in FIGS. 59 and 60 in an expanded and collapsed condition, respectively. The divider 152, as seen in FIGS. 57 and 58, includes a pair of parallel outer crease lines 156 with folds in the same direction therein spaced inwardly from the side edges 158 of a strip of material from which the divider is formed and a third intermediate crease line 160 between the parallel outer crease lines. An upper marginal zone 162 is defined between one edge of the strip of material and one of the outer crease lines and a second much larger lower marginal zone 164 is defined along the bottom of the divider between the associated edge of the strip of material and the adjacent crease line. A fold in an opposite direction is provided at the intermediate crease line 160 so that the divider has upper and lower marginal zones of different widths that both project to the right, as viewed in FIG. 8, from their adjacent fold lines 156. The upper marginal zone 162 of each divider is secured to a connector sheet 166 at parallel equally spaced locations while the lower marginal zones 164 are adapted to extend to the right and overlap a small portion of the next adjacent divider to the right. The overlapping lower marginal zones are secured to each other thereby forming an integrated segmented outer sheet 168 formed from the plurality of lower marginal zones of the respective dividers. Of course, a decorative sheet (not shown) could overlie the interconnected lower marginal zones or the connector sheet to provide variety to the aesthetics of the panel.

[0165] A similar embodiment 170 of a divider is shown in FIGS. 61-64 where, again, a strip of material is provided with a pair of outer crease lines 172 and an intermediate crease line 174 therebetween, with upper and lower marginal zones 176 and 178 being defined between the edges 180 of the strip and the outer crease lines 172. The folds at the outer crease lines 172 are in an opposite direction to the fold along the intermediate crease line 174 so that the outer and lower marginal zones both project horizontally to the right, as viewed in FIG. 62. As will be appreciated, both of the horizontal zones extend horizontally beyond the intermediate crease line 174 and are adapted to overlap the upper and lower marginal zones of adjacent dividers to the right so that they can be secured thereto in any suitable manner to form the panel shown expanded in FIG. 63 and compressed in FIG. 64.

[0166] In a further embodiment of a panel 182 made in accordance with the teachings of the present invention, and as seen in FIGS. 68-73, the panel again has an outer sheet 54, a connector sheet 56 and a plurality of dividers 184 extending therebetween. As is probably best seen in FIGS. 68 and 71, the dividers 184*a* in a part of the panel are of Z-shaped cross-section while the dividers 184*b* in the other part of the panel are of reverse Z-shaped cross-section. At the location 186 at which the direction of the dividers changes, the panel can be bent at a right angle as seen in FIGS. 72 and 73 so that the panel can, for example, follow the right-angled contours of building components on which it is mounted. For example, the panel could be wrapped around rectangular ductwork of the type that might be found in a house for conducting forced air or the like.

[0167] Referring again to FIGS. 68 and 71, it will be appreciated on the right-hand portion of the panel that the dividers 184*a* are Z-shaped in cross-section so as to define an upper horizontal leg 188 that extends to the left, a lower horizontal leg 190 that extends to the right and a diagonal connecting leg 192 that connects the right edge of the upper leg to the left edge of the lower leg. The Z-shaped dividers 184*a* are, of course, formed similarly to those described previously by placing crease lines in strips of material from which the dividers are made and then folding the strips of material along the crease lines. The reverse Z-shaped dividers 184*b* on the left side of the panel, of course, have an upper horizontal leg 194 that extends to the right, a lower horizontal leg 196 that extends to the left and a diagonal connecting leg 198 that extends from the left edge of the upper leg to the right edge of the lower leg.

[0168] As is best seen in FIGS. 68 and 71-73, at the location 186 where the direction of the dividers changes, (in the illustrated panel, near its center) the panel can be folded at a right angle. The panel can then be filly expanded as shown in FIGS. 72 and 73 so that the legs of the dividers are perpendicular to each other thereby forming rectangular cells.

[0169] With reference to FIGS. 68 and 69, it will be appreciated that the panel can also be compressed as with the earlier described embodiments of panels made in accordance with the present invention.

[0170] The panel is also amenable to rigidification in a cross-direction in a manner illustrated in FIGS. 74-79. It will there be appreciated that a segment of the panel near an end thereof can be partially cut at 89 by cutting through the connector sheet 56 and the dividers 52 (in a direction transverse to the length of the dividers) but not severing the outer sheet 54. This cut forms a small band 91 of material, which can be independently compressed as illustrated in FIG. 75 to receive a rigidifying clip 93. The rigidifying clip in the disclosed embodiment is of substantially J-shaped cross-section having a long side 95, a spaced parallel short side 97, a connecting wall 99 interconnecting corresponding edges of the long and short sides and a lip 101 depending from the long side along the opposite edge from the connecting wall 99. The clip is mounted on the compressed band of material so as to retain the material in a compressed state. The clip and compressed material can then be folded upwardly as shown in FIGS. 77 and 78 to form a rigidification along the end of the panel. Of course, the rigidified band of material can be adhesively secured in position after it has been folded upwardly as illustrated in FIGS. 78 and 79 if desired.

[0171] The clip, with appropriate modification readily evident to those skilled in the art, can also be used as a mounting clip for suspending the panel from ceiling support members (not shown) such as of the type described in co-pending application Ser. No. 08/752,957, filed Apr. 10, 2000, entitled A Cladding System and Panel for Use in Such System, which is of common ownership with the present invention. That application is hereby incorporated by reference.

[0172] It should be further understood from the above description of the various embodiments of the present invention that the dividers each have unique features that could be incorporated into the other embodiments. By way of example only, the upper and lower portions of the side partitions of the various dividers or the upper and lower portions of the walls separating the upper and lower marginal zones could be of the same or different dimensions so as to define symmetric and asymmetric dividers. Further, simply changing the angle in the side partition of a divider causes one panel to be more compressible than another. Similarly, by spacing the dividers at greater distances, the panel would be more easily bendable in a transverse direction to the dividers. The depth of the dividers will also affect the strength of the panels (assuming other parameters remain unchanged) so that the length and width of a panel (i.e. the span) can be significantly enlarged without altering strength or bonding characteristics of the panel simply by increasing the depth of the dividers. Also, as mentioned previously, numerous aesthetics and acoustical properties can be created by laminating different types of decorative sheets to the outer sheet of the panel so that one might create a different color, pattern, texture, or the like to the interior of the room in which the panel is used.

[0173] It will further be appreciated from the above description that the material from which the outer sheet, connector sheet or dividers is made can be varied to achieve different characteristics for the panel. For example, the materials could be varied to obtain different acoustic characteristics for the panel or to obtain different light transmitting characteristics. Also, the materials could be fire retardant to inhibit the spread of a fire in a building in which the panels were being used. It would also be possible to utilize different materials in the panel with for example the cover sheet or the connector sheet being made of the same or different materials and the dividers also being made of a material that is the same as or different from one of the cover or connector sheets. The dividers themselves might be made of different materials in a single panel. For example certain dividers may be provided to obtain the resilient and compressible feature of the panel while other dividers might be provided to vary the acoustics, light transmitting or fire retardant capabilities of the panel. Also, the panels could be stacked in a building structure to alter the acoustic or light transmitting characteristics of the panels.

[0174] While the panels previously described have principally been described for use as a replacement to conventional acoustical tiles that are supported on the T-shaped support members of a drop ceiling gridwork, the panel can be modified slightly so as to also be suspendable from the same T-shaped support members. As will be appreciated, by suspending panels of the present invention from the T-shape support members 60, the panels can be used to replace or renew an existing ceiling system with or without removing the acoustical tiles positioned or supported on top of the T-shaped support members 60.

[0175] A panel 200 that has been modified to be suspendable from or supportable by the T-shaped support members 60 is shown in FIGS. 80-96 with a plurality of the panels shown in FIG. 8 installed in underlying relationship to existing acoustical panels 202 supported on support members 60. As will be appreciated, each panel 200 is of the general type previously described and as seen in FIGS. 84-86 has an outer sheet 204, a connector sheet 206, and a plurality of parallel cellular dividers 208 therebetween. The cellular dividers are preferably, as previously described, compressible in nature and best seen in FIGS. 87-91 as being formed from individual strips of material that have been creased and folded so as to define elongated tubes having two truncated triangular areas 210 and 212 superimposed upon each other. The dividers 208 have collapsible intermediate side walls 214 with fold lines 216, which allow the side walls to either collapse inwardly as shown in FIGS. 89-91 or expand outwardly as shown in FIGS. 87 and 88 depending upon a number of conditions including the type of binder used in the fiberglass matting material from which the dividers are made and the treatment of the dividers to heat and cold which will be described in more detail later.

[0176] At each end of the panel 200 along the open ends of the cellular dividers 208, a unique clip 218 as seen best in FIGS. 81-86, is secured to the panel. The clips are elongated and preferably extruded members of a rigid mate-

rial such as aluminum, plastic, or the like and are generally of inverted J-shaped configuration as probably best seen in FIG. 82. They therefore define a vertical main flat body 220 with a lower protruding lip 222 from the bottom edge of the main body. An upper downwardly opening hook-shaped channel 224 extends from the upper edge of the main body. Also along the upper edge is formed a second or horizontally opening hook-shaped channel 226 which protrudes from the main body in the opposite direction as the lip 222. An obliquely protruding rib 228 extends downwardly from the upper edge of the main body beneath the horizontally opening channel 226.

[0177] With reference to FIGS. 92-95, the clip 218 is secured to the end of the panel 200 either by notching the end of the panel, as described previously, so that the outer sheet 204 protrudes longitudinally from opposite ends of the panel or the outer sheet can be made slightly longer and wider than the remainder of the panel so that it naturally protrudes from opposite ends and opposite sides as shown in FIGS. 87 and 92 defining outer sheet longitudinal extensions 230 and outer sheet lateral extension 232. An elongated straight stiffening strip 234, which might be made of plastic, aluminum, paperboard, or the like, is adhesively bonded to the top surface of the outer sheet longitudinal extension 230 where it protrudes from the ends of the panel and clips are thereafter positioned over the outer sheet longitudinal extensions and the stiffeners as shown in FIG. 94 by inserting the stiffener strips and outer sheet longitudinal extensions into the downwardly opening J-shaped channels 224 adjacent to the main bodies with the lip 222 hanging over the innermost edge of the stiffeners. With the clips so positioned, the outer sheet longitudinal extensions 230, stiffener 234 and clip 218 can be folded upwardly as shown in FIG. 95 until the connector sheet 206 at opposite ends of the panel is received between the horizontally opening J-shape channels 226 and the oblique ribs 228 of clips. The underside of the horizontally opening J-shaped channels 226 can then be adhesively or otherwise secured to the connector sheet 206 to hold the clip in the position illustrated in FIG. 95.

[0178] The oblique rib 228 of each clip projects beneath the connector sheet 206 so as to hold the panel in a fully expanded position. By following the same procedure at each longitudinal end of the panel, it will be appreciated that each panel will have a clip thereon and the horizontally opening J-shaped channels 226 are positioned to be secured to a flange of the T-shaped support member 60 as shown in FIGS. 84 and 85.

[0179] An alternative way for securing a J-shaped clip to ends of the panel is shown in FIGS. 92A-95A. In the alternative system, at an open longitudinal end of a panel, a cut or slit is made downwardly through the connector sheet 206 and the open ends of the dividers 208 as shown in FIG. 92A, so as to define a slight gap between the severed portions of the connector sheet and the dividers and the remainder of the panel. The connector sheet and dividers are then compressed downwardly into closely adjacent relationship with the outer sheet 204 and this compressed material is then inserted into the downwardly opening J-shaped channels 224 of the clip so that the lip 222 of the clip hangs over the innermost edge of the compressed material, as shown in FIG. 94A. The clip with the compressed material confined therein is then folded upwardly as shown in FIG. 95A and secured in position, preferably with adhesive so as to define a longitudinal end of a panel.

[0180] As illustrated in FIG. 83, the ends of the horizontally opening J-shaped channels 226 are spaced inwardly from opposite longitudinal ends of the clip 218 to accommodate a T-shaped support member 60 that extends perpendicularly to the T-shaped support member 60 to which the clip is secured. In this manner, the panels can be supported by a conventional gridwork of T-shaped support members in a suspended rather than supported manner with or without another set of acoustical tiles being supported by the gridwork. In other words, the panels 200 with the clips 218 secured thereto can be used in connection with an existing gridwork or in connection with a new gridwork in exactly the same manner. As will also be appreciated, the clips of adjacent longitudinally aligned panels can abut each other (FIG. 85) so the ends of the outer sheets of the panels are only slightly spaced to give a substantially continuous appearance to the ceiling with virtually no view of the gridwork from which the panels are suspended. Further, due to the fact that the clips hold the panels in their fully expanded position, the lower or outer sheet 204 of each panel will be horizontally aligned with the outer sheet of an adjacent panel to give a smooth uniform appearance to a ceiling formed from such panels. Referring to FIGS. 87-91, the outer sheet lateral extensions 232 can be folded up into engagement with the adjacent sidewall 214 of the outermost divider and secured thereto with a suitable adhesive to give the panel a finished look along its side edges.

[0181] Sometimes it might be desirable to fold a panel around a corner or to form a corner. With the panel of the present invention, such a fold or corner can be made in an aesthetically attractive manner as illustrated in FIGS. 97 and 98. It will be seen in FIG. 97 that a divider 208 including the connector sheet 206 across the top thereof can be severed from the remainder of the panel at the location where a fold or bend is desired in the panel leaving the outer sheet 204 where the divider was removed. The remaining portions of the panel can be folded in one direction or the other as illustrated in FIG. 98 so that one remainder portion of the panel is oriented perpendicularly to the other portion with the outer sheet 204 extending continuously around the bend so as to define a fully finished corner for the panel. Such a fold in the panel might be desirable, for example, in a skylight where a window is raised above the ceiling level into an upwardly recessed area and by following the procedure shown in FIGS. 97 and 98, a panel or panels can be folded to extend from the normal ceiling level up into the recessed area of the skylight.

[0182] As mentioned previously, the preferred material from which the dividers are made includes glass fibers and a mixture of a thermoset resin and a thermoplastic resin. The material so formed wants to remain in a flat planar orientation even after having been creased and folded as described previously into the configuration of the divider as illustrated for example in FIGS. 89-91. In order to retain the folded configuration with the side walls 214 of each divider folded inwardly, the panel 200 over a long period of time needs to be held in at least some compression or the folded side walls will fold outwardly in an effort to return to the flat planar orientation. Of course, the dividers cannot return to the flat planar orientation as they are secured along the top and bottom to the outer sheet 204 and connector sheet 206

but the side walls will over some period of time try to straighten out if not held in compression and when doing so, pass from their inwardly folded orientation of FIG. 89 to their outwardly folded orientation of FIG. 88 wherein the side walls abut the side walls of adjacent dividers thereby being mutually reinforced and rigidifying the panel so that it is virtually incompressible. A panel in its substantially incompressible condition is shown in FIG. 96. In other words, to maintain the compressible nature of a completed panel, the sidewalls need to be folded inwardly as shown in FIGS. 89-91.

[0183] The strips of material from which the dividers 208 are made are folded in an unheated environment and a hot melt adhesive is applied to the strips or to the outer sheet 204 and connector sheet 206 before they are laminated together. As mentioned previously, unless the panels 200 are maintained in a compressed configuration such as illustrated in FIGS. 89-91, they will, over some period of time, expand into the configuration of FIG. 88 in which configuration the panel is no longer compressible. This time period over which it takes for the dividers to convert from the configuration of FIGS. 89-91 to the configuration of FIG. 88 is dependent upon a number of factors including the resin used in the material from which the dividers are made and also whether or not heat is applied to the material while the dividers are in the compressed configuration of FIGS. 89-91. By adding heat to the dividers while they are compressed, the time period it takes for them to expand into the configuration of FIG. 88 is lengthened. Also, by increasing the percent of thermoplastic resin used in the formation of the material from which the dividers are made, the time in which it takes for the dividers to transform from the configuration of FIG. 89 to the configuration of FIG. 88 can be increased. By way of example, the time period for the transformation may be varied anywhere from 15 minutes to 32 hours.

[0184] Accordingly, when the panels 200 are formed and shipped, they are desirably shipped in a compressed state so that a relatively large number of panels can be packed and shipped in a relatively small container particularly in comparison to conventional acoustical tiles of a fixed depth, i.e., a depth similar to the fully expanded depth of a panel 200 in accordance with the present invention. Once the panels are removed from the shipping container, however, they expand immediately from the configuration shown in FIG. 91 through the configuration shown in FIG. 90 to the configuration shown in FIG. 89. They will remain in the configuration of FIG. 89 for the above-noted time period after which they will transform into the configuration shown in FIG. 88 where the panel becomes incompressible. During that time period, the panels can be cut to their desired shape and installed in a supporting grid system before the panels become substantially incompressible. They can therefore be flexed for easy insertion into the openings defined between support members in the supporting grid system if inserted before becoming incompressible.

[0185] As mentioned previously, panels formed in accordance with the present invention have desired acoustical properties and can be varied according to various parameters. In comparing one embodiment of the present invention with conventional acoustical tiles, one can see the acoustical benefit obtained from a panel formed in accordance with the present invention. In FIG. 99, a graph comparing the panel of FIG. 14 of the present invention with other acoustical tiles is illustrated. The X-axis references frequency in hertz while the Y-axis references a noise reduction coefficient. The three panels compared to the panel formed in accordance with FIG. 14 of the present invention are a hard mineral acoustical tile panel manufactured by Armstrong under the trademark "Cirrus," a glass fiber tile of two-inch thickness manufactured by Ecophon of Sweden under the trademark "Focus," and a 0.7 mm metal panel with perforations and an overlying sheet of a non-woven fleece manufactured by Hunter Douglas of Rotterdam, Holland, under the designation Luxalon 300C.

[0186] As can be seen, the acoustical panel of FIG. 14 performs superiorly to the three compared panels at lower frequencies as well as at fairly high frequencies and performs comparably at intermediate frequencies.

[0187] Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made by way of example, and changes in detail or structure may be made without departing from the spirit of the invention as defined in the appended claims.

1. A compressible structural panel comprising in combination:

at least one outer sheet of material having an inner and outer face,

a plurality of dividers that in a resting condition are expanded and secured to and protrude from said inner face, said dividers being compressible, and

connector means for flexibly securing said dividers together at locations distal from said outer sheet.

2. The panel of claim 1 wherein said dividers are elongated and extend in parallel relationship to each other.

3. The panel of claim 1 or 2 wherein said dividers are made of a semi-rigid material.

4. The panel of claim 3 wherein said dividers are independent of each other.

5. The panel of claim 4 wherein said dividers are foldable into said compressed condition.

6. The panel of claim 4 wherein said dividers are biased toward the resting condition.

7. The panel of claim 6 wherein said dividers are made from independent sheets of a semi-rigid but foldable material, said sheets being folded such as to define flaps that are securable to said outer sheet and said connector means and a pair of partitions extending between said outer sheet and said connector means, said partitions being collapsible.

8. The panel of claim 7 wherein said partitions are substantially elongated and planar having a longitudinally extending fold therein which allows the partition to be folded into substantially face-to-face relationship with said flaps when in the compressed condition.

9. The panel of claim 7 wherein said sheets are made of fiberglass including a plurality of glass fibers bonded together with a resin.

10. The panel of claim 9 wherein said resin is thermal setting.

11. The panel of claim 9 wherein said resin is thermal plastic.

12. The panel of claim 9 wherein said outer sheet is fiberglass.

13. The panel of claim 12 wherein said connector means is a sheet of material.

14. The panel of claim 13 wherein said connector means is a fiberglass sheet.

15. The panel of claim 12 wherein said connector means includes a plurality of flexible but non-extensible fibers connected to said dividers.

16. The panel of claim 1 or 7 wherein said panel is a ceiling panel.

17. The panel of claim 7 wherein said partitions include a longitudinal fold defining a pair of partition portions.

18. The panel of claim 17 wherein said panel portions are of the same size.

19. The panel of claim 17 wherein said panel portions are of different sizes.

20. The panel of claim 1 further including a decorative sheet secured to the outer face of said outer sheet.

* * * * *

Best Available Copy

Filed 8/25/06

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaffee et al

Art Unit: 1771

Case Docket No.7237

Serial No. 10/718,007

Examiner: Torres Velazquez, Norca Liz

Filed: November 20, 2003

For: **Method of Making Tough, Flexible Mats and Tough Flexible Mats**

Commissioner of Patents and Trademarks
Washington, D. C.
Dear Sir:

DECLARATION UNDER 37 CFR 1.132

I, Alan M. Jaffee, hereby declare that:

1. I received Bachelor of Science and Master of Science degrees in Chemical Engineering from the University of Toledo in 1977 and 1985, respectively. I have worked in the chemical industry since 1976 and have been employed by Johns Manville, Inc., Waterville, OH, since 1983, working in the area of sized glass fibers and fibrous nonwoven mats. For the last twenty-three (23) years my duties at Johns Manville have included the research, development, and application of glass fibers and non-woven products made therewith. I am currently a Technical Leader in the development of new fibrous nonwoven mats.

2. I am a joint inventor of the subject matter of the above-identified application Serial No. 10/718,007. I have read the application, and the Final Office Action mailed March 14, 2006, and the Advisory Action mailed June 12, 2006. I have also read the amended claims submitted with applicants' responses dated May 16, 2006.

3. I have read each of US Patent Application No. 2003/0109190 to Geel and US Patent Nos. 5,661,213 to Arkens et al and 4,888,235 to Chenoweth et al, which were cited in the March 14, 2006 Final Office Action.

4. I disagree with the Examiner's conclusion that the invention was obvious at the time it was made from the teachings of these references for the following reasons:

a) I believe that my credentials stated above qualifies me to have more than ordinary skill in the art pertinent to the claimed invention of this application. I was familiar with the teachings on all three patents cited above in paragraph 3 above and these teachings did not make my invention obvious to me! Instead I made more than 100 trials of different types of glass fibers with and without various amounts of polymer fibers and/or different kinds of glass microfibers looking at different ratios of these combinations of fibers with different amounts of more than 7 different types of binders before I could find the claimed invention. These more than 100 trials took more than 54 days of experimentation and testing to find the claimed invention, a suitable range of compositions and mat parameters suitable for the scored and foldable mat for the vertical supports in the ceiling tile disclosed inf U.S. Published Patent Application No. 20020020142.

b) The products that the mats of the claimed invention were designed for are for ceiling tiles of the type disclosed in US. Pat. App. No. 2002020142 as pointed out in the specification. In that patent application, the mats that were said to perform as the dividers, i.e. the mats that have to be scored and folded and then have the properties that will cause the ceiling tile to spring back into the proper thickness after having been compressed for storing and shipping and storing awaiting use, were mats disclosed in three patents owned by the assignee of the present invention, particularly US 5,840,413 and 5,942,288. The mats taught in those patents contained expensive glass microfibers, i.e. having diameters below 5 microns, and bound with a melamine formaldehyde binder. The mats of the present invention do not require the presence of fine glass fibers to meet the requirements for the dividers in the ceiling tile and I believe this is <u>an unexpected result of the combinations claimed</u>.

2

c) The reasons that the Geel et al reference does not lead one skilled in the art to the claimed invention is because it would lead one skilled in the art AWAY from the claimed invention. Geel et al discloses a very broad range of compositions of mats for serving as a backing for a vinyl flooring product, not mats that must have a high Taber Stiffness or having unexpected excellent flex and recovery properties after scoring and folding. Geel et al makes no suggestion that his mat has the properties needed for use in ceiling panels of the type described in U.S. Published Patent Application No. 20020020142 and the mats of the claimed invention. Nor does Geel et al teach a mat composition even near that claimed in this application. Geel et al teaches applying a first binder in amounts of 5-35 wt. percent of the fibers in the formed web and then applying a second binder in amounts of an additional 10-30 wt. percent of the of the fibrous mat, amounting to almost 15-65 wt. percent of binder. If I had followed this teaching I would never have arrived at the invention because I would be trying to make a mat containing a combination of polyvinyl alcohol or acrylic or ethylene vinyl acetate or mixtures thereof, probably a mat containing in the neighborhood of about 25 – 40 wt. percent of glass fibers and about 60-75 wt. percent of PET fibers. Even if it would have been obvious to try the type of binder taught by Arkens et al as the secondary binder, I would not have arrived at the claimed invention because the mats of the claimed invention do not contain polyvinyl alcohol or acrylic or ethylene vinyl acetate or mixtures thereof – no where does Geel et al suggest that his primary binder is not necessary.

d) The Examiner states that no weight is given to the mat properties, seemingly stating that any mat in the mats falling within the fiber and binder compositon ranges taught by Geel, but modified by using binder taught by Arkens et al will <u>inherently have the properties of the claimed mats</u> i.e. applies the flex properties following scoring and folding, the flamibility test results, the Taber Stiffness and the ratio of wet tensile to dry tensile strengths. This allegation is incorrect as demonstrated by several trials included in the more than 100 trials I ran and mentioned above. For example, the following trials produced mats having a Taber Stiffness of less than 20.

3

i) Trial designated 03160C, a mat containing fibers consisting of 85 percent M (15-16 micron diameter) glass fibers 1 inch long and 15 percent 1/4 inch long 1.5 denier PET fibers. The mat contained 23 wt. percent of a melamine formaldehyde binder, a binder that bonding effect at a temperature of from about 80–200 degrees C. as Geel et al teaches. The mat had a basis weight of 2.24 lbs./100 sq. ft. and a thickness of about 38.5 mils. However, the Taber Stiffness of this mat was only 32.1, <u>substantially outside the limits of the mats of the claimed invention</u>.

ii) Trial designated 04213a, a mat containing fibers consisting of 86.9 wt. percent 12 mm long, H117 fibers (9-10 microns diameter) and 13.1 wt. percent 6 mm long polyester (PET) fibers of 1.5 denier and 24 wt. percent of Type 82 binder, the binder described in the claimed invention. The mat had a basis weight of 1.08 lbs/100 sq. ft. and a thickness of 19.5 mils. The mat was wet laid, the binder added in an aqueous mixture and the wet mat was dried and cured at a temperature of about 121 degrees C. for 120 seconds. The Tabor Stiffness of the resultant mat was only about 18, <u>substantially outside the level of the mats of the claimed invention</u>.

iii) Trial designated 02122a was a mat containing fibers consisting of about 81 wt. percent 12 mm long, H117 fibers (9-10 microns diameter) and about 19 wt. percent 6 mm long polyester (PET) fibers of 1.5 denier and 24 wt. percent of Type 82 binder, the binder described in the claimed invention. The mat had a basis weight of 1.08 lbs/100 sq. ft. and a thickness of 19.5 mils. The mat was wet laid, the binder added in an aqueous mixture and the wet mat was dried and cured at a temperature of about 120 degrees C. for 120 seconds. The Taber Stiffness of the resultant mat was only about 14, <u>substantially outside the level of the mats of the claimed invention</u>.

4

e) The disclosure of Chenoweth et al adds nothing of any value because Chenoweth et al also lead one skilled in the art away from the claimed invention in the following ways:

i) The fibers taught by Chenoweth, rotary spun fibers having a diameter of 3-10 microns are a totally different type of fiber than the chopped continuous glass fibers used in the claimed invention and would not produce the properties needed for the ceiling tiles of the type disclosed in US. Pat. App. No. 2002020142 because due to the type of fiber and the small fiber diameter the Taber Stiffness required would not be achieved based on what I have learned in the more than 100 trials I have run. Further, based on my actual experience of trying to use rotary spun glass fibers of the size and type taught by Chenoweth et al to make NOWOVEN MATS, a brashy, weak mat would result that would be totally unacceptable for the ceiling tile described above.

ii) The fiber ratios in Table I lead away from the claimed invention, note that the ratio of glass fibers to synthetic fibers is 33-90 : 30-50 resulting in a composition of fibers in the mat being, at the most, three times as much glass fiber as synthetic fiber. This is clearly substantially outside my claimed invention requiring at least 5-6 times as much 13-17 micron glass fiber as polymer fiber and up to about 8-9 times as much.

iii) Chenoweth teaches a different type of product, an insulating blanket having a thickness of about 1-3 inches. While the reference teaches that thicker or thinner blankets can be produced, one skilled in the art will readily recognize that Chenoweth did not teach making a nonwoven fibrous mat having a thickness of 43 +/- 5 mils, 0.038-0.048 inches, a distinctly different type of product.

PAGE 85/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10

f) While Arkens et al is pertinent to the binder in the claimed invention, the Arkens et al disclosure does not suggest the claimed invention and does not change the direction of the teachings of Geel et al or of Chenoweth et al.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed: Alan M. Jaffee

Alan M. Jaffee
822 Touraine Ave.
Bowling Green, OH 43402

Date: 8/21/06

6

Filed Nov. 19, 2008

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaffee et al   Art Unit: 1771

Serial No. 10/718,007   Case Docket No.7237

Filed: November 20, 2003   Examiner: Matzek, Matthew D.

For: **Method of Making Tough, Flexible Mats and Tough Flexible Mats**

Commissioner of Patents and Trademarks
Washington, D. C.
Dear Sir:

DECLARATION UNDER 37 CFR 1.132

I, Alan M. Jaffee, hereby declare that:

1. I received Bachelor of Science and Master of Science degrees in Chemical Engineering from the University of Toledo in 1977 and 1985, respectively. I have worked in the chemical industry since 1976 and have been employed by Johns Manville, Inc., at the Waterville, OH, facilities since 1983, working in the area of sized glass fibers and fibrous nonwoven mats. For the last twenty-five (25) years my duties at Johns Manville have included the research, development, and application of glass fibers and non-woven products made therewith. I am currently the Principal Technical Advisor in the development of new fibrous nonwoven mats.

2. I am a joint inventor of the subject matter of the above-identified application, Serial No. 10/718,007, filed November 20, 2003.

3. I am also the inventor of the invention disclosed in U.S. Patent 5,772,846, and state that the stiffness data shown in Examples 1, 2 and 3 and in the Table were determined using the Taber Stiffness Test and that this data is Taber Stiffness. This Taber Stiffness Test is the same test used to determine the

stiffness data presented in the above-identified application, Serial No. 10/718,007, filed November 20, 2003.

4. Example 2 in U.S. Patent 5,772,846 was Johns Manville's commercial mat product designated by Johns Manville as Duraglass® 8802 mat. This Duraglass® 8802 mat is unsuitable for the collapsible web of the compressible ceiling tiles disclosed in U. S. Published Patent Application No. 20020020142 filed April 23,2001, because of insufficient stiffness and because it doesn't pass the National Fire Protection Association's (NFPA) Method #701 Flammability Test.

5. Example 3 and the other mats of the invention disclosed in U.S. Patent 5,772,846 are also unsuitable for the collapsible web of the compressible ceiling tiles disclosed in U. S. Published Patent Application No. 20020020142 filed April 23,2001, because of insufficient stiffness and because the smoke toxicity upon burning of the PVC binder in the mat was unacceptable.

6. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed: Alan M Jaffee

Alan M. Jaffee
822 Touraine Ave.
Bowling Green, OH 43402

Date: 11/14/07

Exhibit 1

HunterDouglas Ceilings

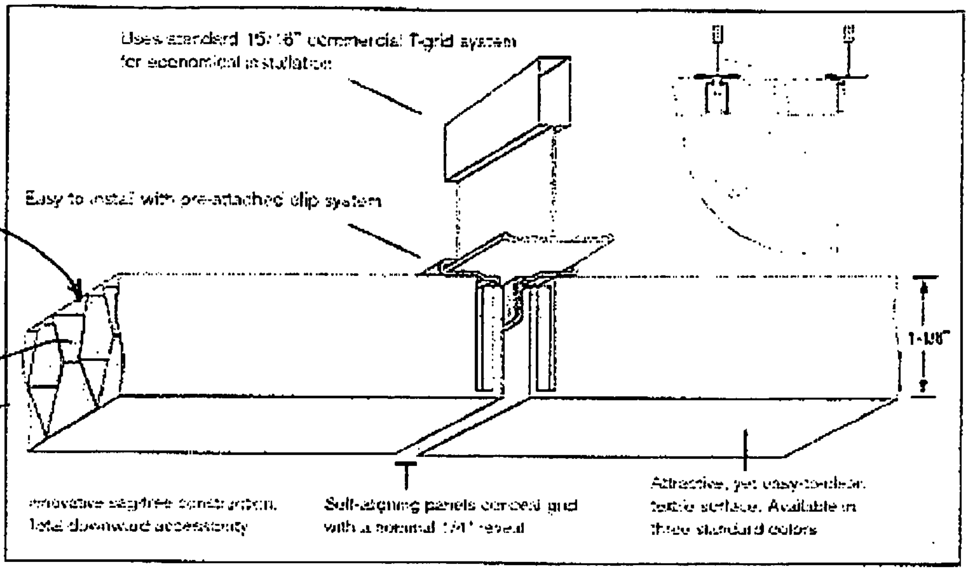
Construction Details

Techstyle Acoustical Ceilings Classic Series

onnector,

Backer MAT

Divider



CHARACTERISTICS

Substrate:	Acoustical mat
Surface finish:	Polyester Non-woven material
Panel Thickness:	1 1/8"
Panel Sizes:	24"x24" 30"x30" 48"x 48" 24"x48" 30"x60" 48"x 60" 24"x60" 48"x 72" 24"x72"
Material/sqm:	Approx 1/4 lb / SF
Light Reflectance:	LR-1 (77%) (ASTM E 1477) (White only)
Weight of Panel:	0.30 pounds per square foot

- Clean, Drywall-like Appearance
- Large panel sizes
- Outstanding acoustical performance
- Easy downward accessibility
- Narrow 1/4" reveal
- Economical installation on standard 15/16" T-grid
- Innovative sag-free construction
- Accommodates standard fixtures

Exhibit 1

HunterDouglasContractCeilings

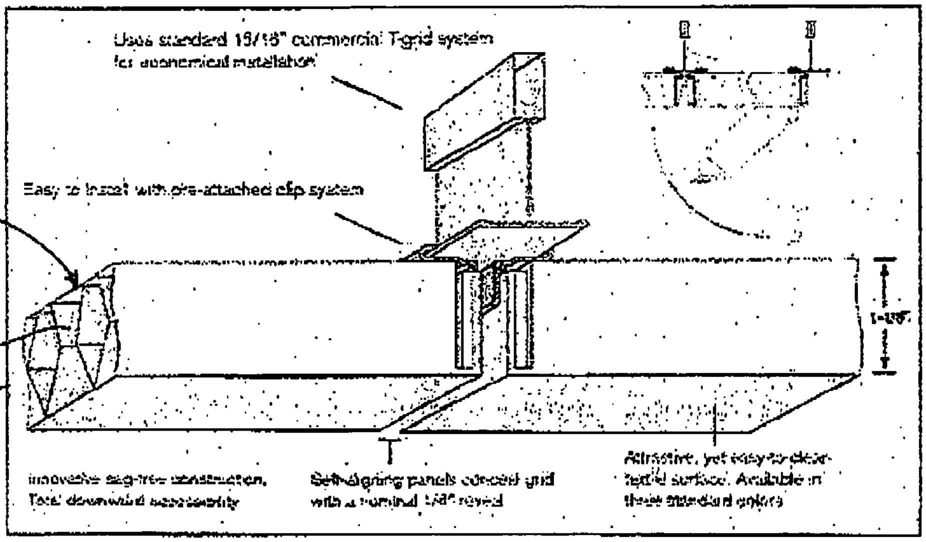
Global > United States > Ceilings > Techstyle Acoustical Solutions > Classic Series

Construction Details

Techstyle Acoustical Ceilings Classic Series

connector,
Backer Mat

Divider



CHARACTERISTICS

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Surface finish:	Polyester Non-woven material
Panel Thickness:	1 1/8"
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Material/sqm:	Approx 1/4 lb / SF
Light Reflectance:	LR-1 (77%) (ASTM E 1477) (White only)
Weight of Panel:	0.30 pounds per square foot

- Clean, Drywall-like Appearance
- Large panel sizes
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- Easy downward accessibility
- Narrow 1/4" reveal
- Economical installation on standard 15/16" T-grid
- Innovative sag-free construction
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X. RELATED PROCEEDINGS APPENDIX

NONE

PAGE 91/91 * RCVD AT 10/21/2008 1:35:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/41 * DNIS:2738300 * CSID:3039782323 * DURATION (mm-ss):14-10